THE TELEGRAPHIC JOURNAL AND

Electrical Review.

Vol. XVI.—No. 391.

OVERHEAD WIRES.

It was only what might have been expected that the report of the Special Committee of the House of Commons upon the subject of telephone and telegraph wires, which we published in full last week, should not meet with universal approval. That section of the public which professes to discover in overhead wires a source of the greatest danger to the safety of the community cannot of course forgive the Committee for coming to the conclusion, so antagonistic to its own cherished views, that "the risk of danger to the public from overhead wires has been very greatly exaggerated." The fact that "the accidents which have been proved in evidence have been few and insignificant" has no weight with those who have already made up their minds beyond all possibility of conviction to the contrary by arguments however forcible and conclusive to ordinary mortals. For want of other grounds upon which to base their continued opposition, they now take exception to the composition of the Committee—an ignoble mode of proclaiming defeat which has been adopted before, but rarely with success.

As for ourselves, we must confess to some hesitation at the first perusal of the report in accepting some of the suggestions of the Committee; but further thought and a more careful study brought clearer light, and, while admitting that with regard to some minor points there may be room for modification, we are of opinion that the recommendations are upon the whole equitable, and such as may readily be carried out with advantage to the companies principally concerned and benefit to the public.

The main features in which reform is advocated are the granting of compulsory powers, subject to appeal, to the Postmaster-General, and the placing of the telephone companies, as his licensees, upon the same footing with himself, with the only proviso that the wires of the companies shall not interfere with those required for the general public telegraphic service. The greatest difficulty which presented itself to our mind was with regard to the proposition to empower the Postmaster-General and his licensees to make attachments to private property with the consent of the occupier only. It seemed at first somewhat unjust that the owner should have no voice in determining whether an attachment should or should not be made to his premises. Similarly also with regard to passing wires over property, without attachment, in which case it is proposed that neither owner nor occupier should have the right of prohibition. But the attendant provisions that no vested interest nor easement should be conferred, that the company should not be relieved from any claim for damage which it might occasion, and, in the former instance, that the consent of the occupier should hold good only during the term of his occupancy, considerably modify the seeming stringency of the powers given to the telephone companies. The right of appeal would always exist, and in cases where positive and permanent depreciation of property would accrue, the local authority, the county court judge, the Railway Commissioners, or whomsoever were constituted the arbitrating authority, would no doubt adjudicate in a fair and equitable manner.

There might very possibly be cases where the objection by owner or occupier would be merely of a fanciful or obstinate character; and no great hardship can be urged where such is over-ruled in the general interest. For example, in an instance of the kind given in evidence before the Committee, where many persons in one locality were desirous of being connected with the telephone exchange, but were prevented in consequence of the inability of the company to obtain permission to run the wires, little sympathy will be felt for those obstructive members of the community who thus, probably for purely sentimental motives, object to the running of lines over their premises. These remarks do not, of course, apply to cases where actual danger is to be anticipated, nor even where inconvenience may be caused; in the latter eventuality compensation might very fairly be awarded, while in the former the local authority might be depended upon to ensure prohibition.

The occurrence and repetition of the phrase "public convenience" in allusion to the telephone in the report has been seized upon in certain quarters as giving an opportunity for the indulgence of a covert sneer at the possibility of a commercial enterprise becoming a service of great public utility. This was scarcely to be expected, perhaps, from those professing at other times an admiration for this wonderful and useful invention; but we may dismiss it with the remark that the same sneer would apply with equal effect to railways, which have long enjoyed precisely the powers, so far as the analogy can extend, now proposed to be granted to the telephone companies.

THEORETICAL AND EXPERIMENTAL RESEARCHES ON THE SECONDARY GENERATORS OF GAULARD AND GIBBS.

By Professor GALILEO FERRARIS.

(*Continued from page* 437.)

Sec. 13.—*Calculations with the results of the experiments made with the electrometer and the electrodynamometer.*

I have said that the principal motive for which I wished to carry out experiments in which the only apparatus used as an instrument of measurement should be a calorimeter, was the desire to check, by a new method, the experiments which others have executed using as instruments of measurement the electrometer of Mascart and the electrodynamometer of Siemens. It is therefore important that I should recompare with the results of some of the electrometrical

experiments of M. Uzel the calculations which I have made with the result of the calorimetric experiments.

The experiments of M. Uzel best suited for calculation are those relating to the secondary generator which Uzel, in the table of his results, calls the *great column*. This apparatus, in fact, differs from that with which I made my calorimetric measurements only in having a core entirely of iron. The greatest interest, for the comparison which I wish to make, attaches to the experiments made with the secondary spiral arranged in series, as it was also in the case studied with the calorimeter.

I take, therefore, from the table of M. Uzel's experiments (sec. 6) the numbers relating to the *great column* arranged in series, and I calculate with it the ratio, u, from the coefficients of practical yield and the corresponding coefficients of theoretical yield, making use of the formula (55).

To make use of this formula in the calculation of the electrometric experiments it is necessary to observe in the first case that $\frac{t' - t'_0}{t - t_0}$ represents the relation between the means of the intensities of the primary and secondary currents so that if, as is done in the table of Uzel's experiments the intensity as indicated by the electro-dynamometer is represented by i and i', we put

$$\frac{t' - t'_0}{t - t_0} = \left(\frac{i'}{i}\right)^2 .$$

It must be observed in the second place that, as is done in the heading of the columns of the same table, if the mean of the squares of the difference of potentials at the two ends of the primary spiral are represented by v^2, and the same mean for the secondary spiral by v'^2, we have

$$v_1\, i = v, \; (r' - \rho')\, i' = v'.$$

If ρ is made $= \rho'$, as it is, in fact, with a very close approximation, the formula (55) may be written :

$$\mu = \frac{(v' + 3\,\rho\, i')\;(v' + \rho\, i')}{(v + \rho\, i)\;(v - \rho\, i)} \qquad (55')$$

Thus the formula contains only the formulæ registered in the tables of experiments, and can be conveniently calculated with logarithms.

The value of the resistance, ρ, of the spirals of the secondary generator with which M. Uzel has experimented is not indicated in the summary of his results. But as, setting aside the core, the secondary generator used was of the same type and of the same dimensions as that upon which I made my calorimetric determinations, and for which I found, as a mean $\rho = 0{\cdot}28$; as further, Gaulard has repeatedly told me that in all the generators of this type the resistance of each spiral was about equal to $\frac{1}{3}$ ohm, we shall certainly not commit an appreciable error by putting $\rho = \rho' = 0{\cdot}30$.

Adopting this value of ρ, I have introduced into the formula (55′) the values of v, v', i, i', registered in M. Uzel's table of results, and I have found the values of μ comprised in the following table.

Relation between effective and theoretical yield deduced from the electrometric experiments of M. Uzel.

r'	$r' - \rho'$	u	δ	δ^2
1·54	1·24	0·90	− 0·09	0·0081
2·30	2	0·99	0	0
4·10	3·80	0·96	− 0·03	0·0009
5·80	5·50	1·06	+ 0·07	49
7·83	7·53	1·02	+ 0·03	9
9·30	9	1·03	+ 0·04	16
10·90	10·60	0·99	0	0
12·90	12·60	0·99	0	0
$n = 8$	Medio =	0·99	$\Sigma\, \delta^2 =$	0·0164

$$\sqrt{\frac{\Sigma\, \delta^2}{n-1}} = 0{\cdot}05 \;, \quad \sqrt{\frac{\Sigma\, \delta^2}{n\,(n-1)}} = 0{\cdot}017 \;.$$

Probable mean error = 0·01.

To facilitate the comparison with the experiments already discussed, I have registered in the table, for each experiment, the value of the external resistance, $r' - \rho'$, of the secondary circuit, and that of the total resistance, r', of the same circuit. I have besides indicated for each value of μ its respective difference δ from the mean and the square δ^2 of the same.

If we make abstraction of the magnitude of the probable errors of the single observations and of the mean, magnitudes which come out greater in electrometric than in calorimetric experiments we find exactly the result to which the calorimetric measurements have led us. The ratio of the coefficients of practical effective yield and the coefficients of theoretical yield is

$$u = 0{\cdot}99.$$

The greater magnitude of the mean error of the actual experiments, compared with that of the errors of the calorimetric observations, is most probably due to the employment of the electro-dynamometer ; and it is to be believed that if all the measurements were made by means of the electrometer the mean error of the single observations would not fall out greater than that in the measurements made with the calorimeter. The use of the electrometer for this kind of measurements is therefore justified, and, as the use of this instrument is very convenient and allows of making many determinations very rapidly, it is not merely admissible, but to be recommended.

SEC. 14.—*Coefficients of yield when the secondary spirals are connected in quantity.*

The secondary generator upon which were performed the experiments of M. Uzel, which we have calculated, was further experimented on with the secondary spiral divided into two equal portions and connected in quantity. The results of the experiments made in this case are registered in the last portion of M. Uzel's table (sec. 6) with the heading : "Large column in quantity by twos." And as the secondary generator has for its main object to produce secondary currents of an intensity greater than that of the primary, and is intended to work normally with the coils connected in quantity, it is important to make use of the experiments of M. Uzel for the application of our formula.

We will determine, as we have done for the case already studied, the relation, u, between the coefficient of effective yield and that of theoretical yield.

In sec. 5 we have demonstrated that if I' represents the maximum theoretical value of the intensity of one of the the partial induced currents which occur in the single secondary coils, the formula which gives the intensity of the primary and secondary currents in the case of a generator arranged in series serve also for the case of a secondary generator with N secondary spirals connected in quantity on the single condition of changing r' into $\mathrm{N}^2\, r'$. By virtue of this proposition the formula (27″) may be changed, for the present case, into

$$\left(\frac{\mathrm{I}}{\mathrm{I}'}\right)^2 = \frac{\mathrm{N}^2\, r' + 2\,\rho}{r^2 - \rho^2}\, \mathrm{N}^2\, r'. \qquad (27''')$$

We have called i the mean intensity of the current of the primary circuit measured with the electrometer, or the electro-dynamometer, the square root of the mean of the squares of the variable intensity ; we will in like manner call i' the mean intensity of the outer secondary circuit, measured in the same manner. We have

$$i^2 = \frac{\mathrm{I}^2}{2}\,, \text{ and } i'^2 = u\, \mathrm{N}^2\, \frac{\mathrm{I}'^2}{2}\,,$$

whence (27″′) gives :

$$u = \frac{(\mathrm{N}^2\, r' + 2\,\rho)\; r'}{r^2 - \rho^2} \left(\frac{i'}{i}\right)^2. \qquad (55'')$$

This formula is substituted in the present case for (55) and includes it as a special case.

To make use for calculation of the experiments made with the electrometer we may eliminate the resistances

r' and r_1 and introduce instead the mean differences of the potentials v and v', measured with the electrometer at the two ends of the primary and at those of the secondary spiral respectively. We have, in fact,

$$(r' - \rho')\, i' = v',\ r_1\, i = v,$$

therefore, bearing in mind that $\rho' = \frac{\rho}{N^2}$,

$$\left(r' - \frac{\rho}{N^2}\right) i' = v' ;\ r_1\, i = v.$$

If we substitute this in (55″) we obtain :

$$u = \frac{(N^2 v' + 3\rho i')\left(v' + \frac{\rho}{N^2} i'\right)}{(v + \rho i)(v - \rho i)}. \quad (55''')$$

In the experiments of M. Uzel to which we will apply the formula $N = 2$, then

$$u = \frac{(4 v' + 3\rho i')\left(v' + \frac{\rho}{4} i'\right)}{(v + \rho i)(v - \rho i)}$$

and if we substitute for ρ its value 0·30 :

$$u = \frac{(4 v' + 0{\cdot}9\, i')(v + 0{\cdot}075\, i')}{(v + 0{\cdot}30\, i)(v - 0{\cdot}30\, i)} \quad (55^{iv})$$

With the values of i, v, i', v', found by M. Uzel and given in the table sec. 6, this formula gives the values of u in the following conspectus :

Values of u for a secondary generator with its secondary coil divided into two parts connected in quantity.

i	v	i'	v'	u	δ	δ^2
12·13	43	23·50	17	0·91	− 0·06	0·0036
,,	88	22·47	40	0·98	+ 0·01	1
,,	114	21·97	54	1·01	+ 0·04	16
,,	149	19·65	70·4	0·97	0	0
,,	168	17·00	80·5	0·98	+ 0·01	1
			Mean =	0·97	$\Sigma\,\delta^2$ =	0·0054

$$\sqrt{\frac{\Sigma\,\delta^2}{n-1}} = 0{\cdot}036\ ,\ \sqrt{\frac{\Sigma\,\delta^2}{n\,(n-1)}} = 0{\cdot}013.$$

Probable mean error = 0·01.

There is thus found, with a probable error of about $\frac{1}{100}$, the value $u = 0{\cdot}97$.

This value is about 2 per cent. less than that which we have found from our calorimetrical experiments, and from the electrometrical experiments of M. Uzel with the secondary spirals of the secondary generator connected in a simple circuit, or, as it is customary to say, in series.

It is easy to see the reason of this fact. The fact is very probably due to the imperfect equality of the electromotive forces in the two parts of the secondary spiral.

It can, in fact, be demonstrated that given the quantity of energy evolved and converted into heat in the total secondary circuit, the proportion in which such energy is divided between the external circuit and the complex of the two induced spirals, varies with the variation of the ratio between the two electromotive forces acting upon these spirals and that of the total energy there is manifested and transformed into heat in the external circuit, a fraction so much the greater as the two electromotive forces approach equality. In other terms, the relation between the energy evolved in the outer circuit and the total energy evolved in the complex of the secondary circuits is greatest when the electromotive forces in the two secondary spirals connected in quantity are exactly equal; it has a less value when there is a difference between the two electromotive forces.

The phenomena which present themselves when the electromotive forces in the two secondary spirals are different are in reality very complicated. But from the influence which the difference of the electromotive forces may have on the distribution of the energy between the two parts of the secondary circuit, we may form an idea by seeing how the thing happens in a case much easier to treat, in which the currents are constant. In this case, supposing the two secondary spirals perfectly equal and there being given ρ their joint resistance, we will call R the resistance of the secondary external circuit, e_1 and e_2 the electromotive forces acting on the two spirals, i_1 and i_2 the intensity of the currents in the same, and i the intensity in the external circuit, we have :

$$\rho\, i_1 + R\, i = e_1$$
$$\rho\, i_2 + R\, i = e_2$$
$$i_1 + i_2 = i.$$

If we call x the ratio between the energy transformed into heat in the outer circuit and the total energy evolved in the secondary circuit, we have :

$$x = \frac{R\, i^2}{\rho\,(i_1^2 + i_2^2) + R\, i^2}$$

From these four equations by eliminating i_1, i_2, i it is easy to deduce

$$x = \frac{R\,\rho}{2R + \rho} \cdot \frac{(e_1 + e_2)^2}{R\,(e_1 - e_2)^2 + \rho\,(e_1^2 + e_2^2)};$$

and if we put

$$e_2 = k\, e_1$$

we may then write

$$x = X\,\frac{\rho}{2}\,\frac{(1+k)^2}{R\,(1-k)^2 + \rho\,(1+k^2)}$$

whence

$$X = \frac{2R}{2R + \rho}.$$

The derivative from x in respect to k is

$$\frac{dx}{dk} = 2R\rho\,\frac{1 - k^2}{[R\,(1-k)^2 + \rho\,(1+k^2)]^2}$$

and is $= 0$ if $k = 1$. The ratio x is therefore maximum when the greatest fraction of the total energy is transformed into heat when $e_1 = e_2$. In this case

$$x = X$$

in all other cases x is equal to the maximum value X multiplied by the fraction

$$\frac{\rho}{2}\,\frac{(1+k)^2}{R\,(1-k)^2 + \rho\,(1+k^2)}$$

To form an idea of the values which this fraction may take when k is different from 1, we will give to k in succession the values

0·99, 0·98, 0·95, 0·90

and we find that the said fraction becomes successively

0·933, 0·930, 0·908, 0·839.

This shows that it is sufficient for the two electromotive forces acting on the two secondary spirals to have one from the other a difference of 1, 2, 5, 10 per cent. to cause the proportion of the external utilisable energy to the total energy to decline 6·7, 7, 9, 16 below its maximum value.

If, as in the experiments executed with the electrometer or with the calorimeter the energy produced in the secondary circuit is valued by deduction from that evolved in the external circuit, which alone is capable of measurement, the coefficient of yield must be found reduced in the proportion of X to x.

As the calculation which we have made refers to the case of continuous currents, we cannot assert that effectively the loss of useful effect which may take place in the secondary generator by reason of an inequality in the conditions of the induced spirals will have exactly the numerical values which we have estimated; but the considerations given show that such losses may in some cases be considerable.

And as the secondary generators are especially intended to act connected in quantity, the considerations referred to must be taken seriously into account in the construction and the use of such apparatus.

If the differences between the electromotive forces acting on the secondary spirals connected in quantity may be considerable, it may also happen that to the given result of the decrease of the coefficient of yield may also be added that, still more grave, of a production of heat in the interior of the apparatus which may interfere with its duration and the regularity of its working.

Probably the best way to avoid such inconveniences will be to abstain from placing many secondary spirals upon one and the same column, and instead to connect in quantity distinct secondary generators in which the most perfect equality practically attainable may be aimed at.

(*To be continued.*)

ON THE CHANGES PRODUCED BY MAGNETISATION IN THE LENGTH OF RODS OF IRON, STEEL, AND NICKEL.*

By SHELFORD BIDWELL, M.A., LL.B.

In order that the results of Joule and Mayer might be comparable with those obtained by the author, he made an attempt to estimate the magnetising forces with which they worked. From data contained in their paper, it was calculated that the strongest magnetising force used by Joule was about 126 units, while the strongest used by Mayer did not on the highest probable estimate exceed 118 units. In the author's experiments the magnetising force was carried up to about 312 units. The metal rods, too, were much smaller than any which had been before used for the purpose, ranging in diameter from 1·40 to 6·25 mm. Their length was in every case 100 mm., and the apparatus was capable of measuring with tolerable certainty an elongation or retraction equal to a ten-millionth part of this length.

By using thinner iron rods and greater magnetising forces than those previously employed, the following curious and interesting fact was established. If the magnetisation be carried beyond a certain critical point, the consequent elongation, instead of remaining stationary at a maximum, becomes diminished, the diminution increasing with the magnetising force. If the force is sufficiently increased, a point is arrived at where the original length of the rod is totally unaffected by magnetisation; and if the magnetisation be carried still further, the original length of the rod will be reduced. It also appeared that the position of the critical point in steel depended in a very remarkable manner upon the hardness or temper of the metal; considerable light is thus thrown on the apparently anomalous results obtained by Joule and by Mayer. Further experiments disclosed strong reason for believing that the value of the critical magnetising force in a thin iron rod was greatly reduced by stretching; this would explain the fact that Joule obtained opposite effects with stretched and unstretched wires.

By ascertaining the relative values of the temporary moments induced by gradually increasing external magnetising forces, an attempt was made to connect the point of maximum elongation with a definite phase of the magnetisation of the several rods in which the elongation had been observed.

Though more experiments must be made before it is possible to generalise from them with perfect safety, the results so far obtained by the author indicate the laws given below. The elongations and magnetisations referred to are temporary only; before the beginning of an experiment the rod was permanently magnetised by passing through the magnetising coil a current equal to the strongest subsequently used. In iron the greatest elongation due to permanent magnetisation was generally found to be about one-third of the total elongation, while in nickel the permanent retraction amounted only to about one twenty-fifth part of the whole.

I.—IRON.

1. The length of an iron rod is increased by magnetisation up to a certain critical value of the magnetising force, when a maximum elongation is reached.

2. If the critical value of the magnetising force is exceeded, the elongation is diminished until with a sufficiently powerful magnetising force it disappears, and if the force is still further increased the rod undergoes retraction. The retraction diminishes

maximum elongation, but there was no indication of a limit, and a stronger magnetising force would have produced further retraction.

3. The value of the external magnetising force corresponding to maximum elongation is, for a given rod, approximately equal to twice its value at the "turning point."

Definition.—The turning point in the magnetisation of an iron bar is reached when the temporary moment begins to increase less rapidly than the external magnetising force.

4. The external force corresponding to the point of maximum elongation increases (when the quality of the iron is the same) with the diameter of the rod. So also does its value at the turning point.

5. The amount of the maximum elongation appears to vary inversely as the square root of the diameter of the rod, when the quality of the iron is the same.

6. The turning point, and therefore presumably the point of maximum elongation, occurs with a smaller magnetising force when the rod is stretched than when it is unstretched.

II.—STEEL.

7. In soft steel magnetisation produces elongation, which, as in the case of iron, increases up to a certain value of the magnetising force, and afterwards diminishes. The maximum elongation is less than in iron, and the rate of diminution after the maximum is passed is also less.

8. The critical value of the magnetising force for a steel rod diminishes with increasing hardness up to a certain point, corresponding to a yellow temper; after which it increases, and with very hard steel becomes very high. There is therefore a critical degree of hardness for which the critical magnetising force is a minimum; in steel of a yellow temper the value of the critical magnetising force is lower than in steel which is either softer or harder.

9. In soft steel a strong magnetising force subsequently diminished may cause a greater temporary elongation than the diminished force is capable of producing if applied in the first place.

10. A temporary elongation when once produced in soft steel may be maintained by a magnetising force which is itself too small to originate any perceptible elongation.

III.—NICKEL.

11. Nickel continues to retract with magnetising forces far exceeding those which produce the maximum elongation of iron. The greatest observed retraction of nickel is more than three times the maximum observed elongation of iron, and the limit has not yet been reached.

12. A nickel wire stretched by a weight undergoes retraction when magnetised.

ON THE SUPPRESSION OF THE NITROUS VAPOURS OF THE BUNSEN BATTERY AND ON A NEW BATTERY WHICH IS DEPOLARISED BY AIR.

By M. A. D'ARSONVAL.

THE suppression of the nitrous vapours in the Bunsen element has occupied many inventors. In a recent memoir M. A. Dupré proposes to add to the nitric acid bichromate of potash for this purpose. This remark was already made by Ruhmkorff, who communicated it to me personally in 1869. The celebrated constructor never omitted indicating this receipt to his clients, and one of them, M. Ernest Saint-Edme, even published it in the following terms in 1871 :—

"M. Ruhmkorff has indicated a process for neutralising the emanations of hyponitric vapours. This process consists in filtering the nitric acid over crystals of bichromate of potash. The electromotive force is not affected, and the emanations cease."

I have often employed this method, which answers very well during the first hours, especially if a very intense current is not required.

The nitrous vapours reappear, though less abundantly, as the battery goes on working. This is quite intelligible: as long as chromic acid exists it oxidises the vapours until it is converted into nitrate of chrome. From that moment the battery acts like one with dilute

The salt of chrome derived from the reduction of the

Digot has shown, to the salts of the protoxide.

liquid is decreased. Further, the presence of nitric acid presents the double inconvenience of giving off acid vapours and attacking the zinc when the circuit is open, which is not the case with Poggendorff's liquid (bichromate and sulphuric acid), especially if we adopt Fuller's arrangement (zinc at the centre, dipping into a little mercury). Batteries of this kind are absolutely inodorous, and act very little when the circuit is open, especially if we take care to purify the sulphuric acid with oil as I have indicated.

In 1880, during the researches cited below, I employed for the suppression of the nitrous vapours a method very efficacious, though scarcely practical, for which reason I have not mentioned it in my memoir.

This method consists in adding urea to the nitric acid. In presence of the nitrous vapours the urea is decomposed; nitrogen and carbonic acid escape, while ammonia and water combine with the excess of nitric acid. The same effect is produced if the nitric acid is diluted with urine. In this case the decomposition, in consequence of the presence of mucus, is attended with a great quantity of froth, but the suppression of the nitrous vapours is as absolute as with pure urea.

The principal inconvenience of Bunsen's battery from an industrial point of view lies not so much in the nitrous vapours given off as in the real waste of nitric acid which it occasions. In a series of researches on batteries I showed that the Bunsen element only utilises for depolarisation about 130 grms. per kilo. of acid, and that the mean weight of the acid expended reaches tenfold the zinc consumed when the battery is required to perform its maximum work. I have indicated for this purpose various means, which have become industrial, for utilising in depolarisation all the nitric acid, and suppressing almost completely the nitrous fumes. For the details I refer to *La Lumière Electrique* (Recherches sur les piles, 1881).

In all batteries with a depolarising agent this is the expensive part; the zinc only plays a relatively insignificant part in the cost of such apparatus.

I have made several attempts to obtain from the air, by an indirect method, a depolariser which costs nothing—*i. e.*, oxygen. The following process has so far given the best results: in a flat Bunsen element I substitute for the nitric acid surrounding the carbon a solution of bichloride of copper in hydrochloric acid. With an open circuit the element has an electromotive force of 1·5 volt. On closing the circuit we obtain a current of 8 to 12 ampères with the flat element of Ruhmkorff's model. The solution of copper is dissolved, the copper is deposited on the carbon, but it does not remain there. In presence of the hydrochloric acid and the air it redissolves almost instantaneously. The re-solution can be rendered more rapid by increasing the surface of the carbon, or by blowing air into the porous vessel.

We see that in this arrangement the chloride of copper is constantly regenerated, and that the real depolariser is the oxygen of the air.

The author gives this process merely to "take date," and promises further particulars.—*Comptes Rendus.*

LAWS OF MAGNETIC ATTRACTION.

In the REVIEW for April 25th we published the results of some experiments gathered from the columns of an American contemporary, in which Mr. W. B. Cooper endeavoured to show that the law of attraction of horse-shoe magnets departs from that of *inversely as the square of the distance*, in proportion as the armatures [illegible] *the maximum force of the magnet.* These experiments the President of the New York Electrical [illegible] and we [illegible] entirety. He speaks [illegible]

upon some principles which should be kept in view when making deductions from such experiments.

It is a geometrical truth that the surfaces of spheres are proportional to the squares of the radii; consequently force, or action proceeding from a centre equally in all directions, must be diffused over the surfaces in the same proportion, and equal parts of surface take on spheres of different dimensions, must receive actions in the inverse ratio of square of the radii, or distances from the acting centre. That means that a surface of, say, a square inch, on a sphere of one foot radius, will be acted upon by the force in its centre with a four times greater intensity than it acts upon a square inch on a sphere of two feet radius, and nine times as strong as it is on every square inch of a spherical surface of three feet radius, &c. Consequently, the total amount of action received by the whole surface of each sphere is equal, whatever be its dimensions, provided the action proceeding from the centre is the same.

This is the case with light. The illumination obtained by any object is inversely proportional to the square of the distance. It is the same with gravitation, provided the central action proceeds from a point, or the distance in question is large enough to consider the dimensions of the acting centre comparatively as a point, without an error of any practical importance. When this is not the case—for instance, when making photometric experiments with a large flat gas flame, at distances, say, only three or four times the width of the flame—the law of inverse squares does not hold. Of this anyone who possesses the facilities for experimenting in this line may satisfy himself.

This, now, is exactly the case with the magnetic experiments reported. The various distances differ only $\frac{1}{6}$th of an inch, while the active parts are by no means points, but lines of nearly one inch in length when the armature is used on edge, or surfaces of almost a square inch when used flat. If such a large surface acts at so small a distance, it cannot be expected that the law of inverse squares could possibly hold, as this is only the case when the distances are so large that the dimensions of the acting centre may be disregarded.

This was the basis upon which Mayce and Martin conducted their experiments. They found that the true law of magnetic force is identical with that of gravitation, namely, inversely proportioned to the square of the distances. They experimented by observing magnetised needles, measuring the angles of deflection at different distances, always large compared with the pole of the magnet. Lambert showed, further, that the force was directly proportional to the magnetic intensity (which depends upon the number of particles magnetised), while it was inversely proportional to the squares of the distances. If here, for magnetic intensity, we substitute mass, we have the identical law as that which prevails in universal gravitation, of which magnetic attraction is only a special and peculiar modification.

Another geometrical truth is that the curved surfaces of cylinders are proportional to their radii simply, and not to their squares, as is the case with spheres; consequently, force, or action proceeding from the whole length of the line of the axis towards the curved surfaces, must be diffused over these surfaces in the same proportion; and equal parts of the curved surfaces of cylinders, of different dimensions, must receive actions in the inverse ratio of the radii. That means that a curved surface of, say, one square inch, on a cylinder of one foot radius, will be acted upon by the linear central force with twice the intensity of that received by a square inch of surface of a cylinder of two feet radius, and three times as much as a square inch on a cylinder of three feet radius, &c. Consequently, the total amount of action received by the whole curved

experiments of M. Uzel the calculations which I have made with the result of the calorimetric experiments.

The experiments of M. Uzel best suited for calculation are those relating to the secondary generator which Uzel, in the table of his results, calls the *great column*. This apparatus, in fact, differs from that with which I made my calorimetric measurements only in having a core entirely of iron. The greatest interest, for the comparison which I wish to make, attaches to the experiments made with the secondary spiral arranged in series, as it was also in the case studied with the calorimeter.

I take, therefore, from the table of M. Uzel's experiments (sec. 6) the numbers relating to the *great column* arranged in series, and I calculate with it the ratio, u, from the coefficients of practical yield and the corresponding coefficients of theoretical yield, making use of the formula (55).

To make use of this formula in the calculation of the electrometric experiments it is necessary to observe in the first case that $\frac{t' - t'_0}{t - t_0}$ represents the relation between the means of the intensities of the primary and secondary currents so that if, as is done in the table of Uzel's experiments the intensity as indicated by the electro-dynamometer is represented by i and i', we put

$$\frac{t' - t'_0}{t - t_0} = \left(\frac{i'}{i}\right)^2$$

It must be observed in the second place that, as is done in the heading of the columns of the same table, if the mean of the squares of the difference of potentials at the two ends of the primary spiral are represented by v^2, and the same mean for the secondary spiral by v'^2, we have

$$r_1 i = v, \; (r' - \rho') i' = v'.$$

If ρ is made $= \rho'$, as it is, in fact, with a very close approximation, the formula (55) may be written :

$$\mu = \frac{(v' + 3\rho i')\,(v' + \rho i')}{(v + \rho i)\,(v - \rho i)} \qquad (55')$$

Thus the formula contains only the formulæ registered in the tables of experiments, and can be conveniently calculated with logarithms.

The value of the resistance, ρ, of the spirals of the secondary generator with which M. Uzel has experimented is not indicated in the summary of his results. But as, setting aside the core, the secondary generator used was of the same type and of the same dimensions as that upon which I made my calorimetric determinations, and for which I found, as a mean $\rho = 0{\cdot}28$; as further, Gaulard has repeatedly told me that in all the generators of this type the resistance of each spiral was about equal to $\frac{1}{3}$ ohm, we shall certainly not commit an appreciable error by putting $\rho = \rho' = 0{\cdot}30$.

Adopting this value of ρ, I have introduced into the formula (55′) the values of v, v', i, i', registered in M. Uzel's table of results, and I have found the values of μ comprised in the following table.

Relation between effective and theoretical yield deduced from the electrometric experiments of M. Uzel.

r'	$r' - \rho'$	u	δ	δ^2
1·54	1·24	0·90	− 0·09	0·0081
2·30	2	0·99	0	0
4·10	3·80	0·96	− 0·03	0·0009
5·80	5·50	1·06	+ 0·07	49
7·83	7·53	1·02	+ 0·03	9
9·30	9	1·03	+ 0·04	16
10·90	10·60	0·99	0	0
12·90	12·60	0·99	0	0
$n = 8$	Medio =	0·99	$\Sigma\,\delta^2$ =	0·0164

$$\sqrt{\frac{\Sigma\,\delta^2}{n-1}} = 0{\cdot}05 \;, \quad \sqrt{\frac{\Sigma\,\delta^2}{n\,(n-1)}} = 0{\cdot}017 \;.$$

Probable mean error = 0·01.

To facilitate the comparison with the experiments already discussed, I have registered in the table, for each experiment, the value of the external resistance, $r' - \rho'$, of the secondary circuit, and that of the total resistance, r', of the same circuit. I have besides indicated for each value of μ its respective difference δ from the mean and the square δ^2 of the same.

If we make abstraction of the magnitude of the probable errors of the single observations and of the mean, magnitudes which come out greater in electrometric than in calorimetric experiments we find exactly the result to which the calorimetric measurements have led us. The ratio of the coefficients of practical effective yield and the coefficients of theoretical yield is

$$u = 0{\cdot}99.$$

The greater magnitude of the mean error of the actual experiments, compared with that of the errors of the calorimetric observations, is most probably due to the employment of the electro-dynamometer ; and it is to be believed that if all the measurements were made by means of the electrometer the mean error of the single observations would not fall out greater than that in the measurements made with the calorimeter. The use of the electrometer for this kind of measurements is therefore justified, and, as the use of this instrument is very convenient and allows of making many determinations very rapidly, it is not merely admissible, but to be recommended.

SEC. 14.—*Coefficients of yield when the secondary spirals are connected in quantity.*

The secondary generator upon which were performed the experiments of M. Uzel, which we have calculated, was further experimented on with the secondary spiral divided into two equal portions and connected in quantity. The results of the experiments made in this case are registered in the last portion of M. Uzel's table (sec. 6) with the heading : "Large column in quantity by twos." And as the secondary generator has for its main object to produce secondary currents of an intensity greater than that of the primary, and is intended to work normally with the coils connected in quantity, it is important to make use of the experiments of M. Uzel for the application of our formula.

We will determine, as we have done for the case already studied, the relation, u, between the coefficient of effective yield and that of theoretical yield.

In sec. 5 we have demonstrated that if I' represents the maximum theoretical value of the intensity of one of the the partial induced currents which occur in the single secondary coils, the formula which gives the intensity of the primary and secondary currents in the case of a generator arranged in series serve also for the case of a secondary generator with N secondary spirals connected in quantity on the single condition of changing r' into $N^2 r'$. By virtue of this proposition the formula (27″) may be changed, for the present case, into

$$\left(\frac{I}{I'}\right)^2 = \frac{N^2 r' + 2\rho}{r'^2 - \rho^2} N^2 r'. \qquad (27''')$$

We have called i the mean intensity of the current of the primary circuit measured with the electrometer, or the electro-dynamometer, the square root of the mean of the squares of the variable intensity ; we will in like manner call i' the mean intensity of the outer secondary circuit, measured in the same manner. We have

$$i^2 = \frac{I^2}{2}, \text{ and } i'^2 = u\, N^2\, \frac{I'^2}{2},$$

whence (27″) gives :

$$u = \frac{(N^2 r' + 2\rho)\, r'}{r'^2 - \rho^2} \left(\frac{i'}{i}\right)^2. \qquad (55'')$$

This formula is substituted in the present case for (55) and includes it as a special case.

To make use for calculation of the experiments made with the electrometer we may eliminate the resistances

r' and r_1 and introduce instead the mean differences of the potentials v and v', measured with the electrometer at the two ends of the primary and at those of the secondary spiral respectively. We have, in fact,

$$(r' - \rho')\, i' = v',\ r_1\, i = v,$$

therefore, bearing in mind that $\rho' = \frac{\rho}{N^2}$,

$$\left(r' - \frac{\rho}{N^2}\right) i' = v';\ r_1\, i = v.$$

If we substitute this in (55″) we obtain:

$$u = \frac{(N^2\, v' + 3\,\rho\, i')\left(v' + \frac{\rho}{N^2}\, i'\right)}{(v + \rho\, i)\,(v - \rho\, i)}. \quad (55''')$$

In the experiments of M. Uzel to which we will apply the formula $N = 2$, then

$$u = \frac{(4\, v' + 3\,\rho\, i')\left(v' + \frac{\rho}{4}\, i'\right)}{(v + \rho\, i)\,(v - \rho\, i)}$$

and if we substitute for ρ its value 0·30:

$$u = \frac{(4\, v' + 0{\cdot}9\, i')\,(v + 0{\cdot}075\, i')}{(v + 0{\cdot}30\, i)\,(v - 0{\cdot}30\, i)} \quad (55^{iv})$$

With the values of i, v, i', v', found by M. Uzel and given in the table sec. 6, this formula gives the values of u in the following conspectus:

Values of u for a secondary generator with its secondary coil divided into two parts connected in quantity.

i	v	i'	v'	u	δ	δ^2
12·13	43	23·50	17	0·91	− 0·06	0·0036
,,	88	22·47	40	0·98	+ 0·01	1
,,	114	21·97	54	1·01	+ 0·04	16
,,	149	19·63	70·4	0·97	0	0
,,	168	17·00	80·5	0·98	+ 0·01	1
			Mean =	0·97	$\Sigma\,\delta^2$ =	0·0054

$$\sqrt{\frac{\Sigma\,\delta^2}{n-1}} = 0{\cdot}036\ ,\ \sqrt{\frac{\Sigma\,\delta^2}{n\,(n-1)}} = 0{\cdot}013.$$

Probable mean error = 0·01.

There is thus found, with a probable error of about $\frac{1}{100}$, the value $u = 0{\cdot}97$.

This value is about 2 per cent. less than that which we have found from our calorimetrical experiments, and from the electrometrical experiments of M. Uzel with the secondary spirals of the secondary generator connected in a simple circuit, or, as it is customary to say, in series.

It is easy to see the reason of this fact. The fact is very probably due to the imperfect equality of the electromotive forces in the two parts of the secondary spiral.

It can, in fact, be demonstrated that given the quantity of energy evolved and converted into heat in the total secondary circuit, the proportion in which such energy is divided between the external circuit and the complex of the two induced spirals, varies with the variation of the ratio between the two electromotive forces acting upon these spirals and that of the total energy there is manifested and transformed into heat in the external circuit, a fraction so much the greater as the two electromotive forces approach equality. In other terms, the relation between the energy evolved in the outer circuit and the total energy evolved in the complex of the secondary circuits is greatest when the electromotive forces in the two secondary spirals connected in quantity are exactly equal; it has a less value when there is a difference between the two electromotive forces.

The phenomena which present themselves when the electromotive forces in the two secondary spirals are different are in reality very complicated. But from the influence which the difference of the electromotive forces may have on the distribution of the energy between the two parts of the secondary circuit, we may form an idea by seeing how the thing happens in a case much easier to treat, in which the currents are constant. In this case, supposing the two secondary spirals perfectly equal and there being given ρ their joint resistance, we will call R the resistance of the secondary external circuit, e_1 and e_2 the electromotive forces acting on the two spirals, i_1 and i_2 the intensity of the currents in the same, and i the intensity in the external circuit, we have:

$$\rho\, i_1 + R\, i = e_1$$
$$\rho\, i_2 + R\, i = e_2$$
$$i_1 + i_2 = i.$$

If we call x the ratio between the energy transformed into heat in the outer circuit and the total energy evolved in the secondary circuit, we have:

$$x = \frac{R\, i^2}{\rho\,(i_1^2 + i_2^2) + R\, i^2}$$

From these four equations by eliminating i_1, i_2, i it is easy to deduce

$$x = \frac{R\,\rho}{2\,R + \rho} \cdot \frac{(e_1 + e_2)^2}{R\,(e_1 - e_2)^2 + \rho\,(e_1^2 + e_2^2)};$$

and if we put

$$e_2 = k\, e_1$$

we may then write

$$x = X\,\frac{\rho}{2}\,\frac{(1+k)^2}{R\,(1-k)^2 + \rho\,(1+k^2)}$$

whence

$$X = \frac{2\,R}{2\,R + \rho.}$$

The derivative from x in respect to k is

$$\frac{dx}{dk} = 2\,R\,\rho\,\frac{1 - k^2}{[R\,(1-k)^2 + \rho\,(1+k^2)\,]^2}$$

and is $= 0$ if $k = 1$. The ratio x is therefore maximum when the greatest fraction of the total energy is transformed into heat when $e_1 = e_2$. In this case

$$x = X$$

in all other cases x is equal to the maximum value X multiplied by the fraction

$$\frac{\rho}{2}\,\frac{(1+k)^2}{R\,(1-k)^2 + \rho\,(1+k^2)}$$

To form an idea of the values which this fraction may take when k is different from 1, we will give to k in succession the values

0·99, 0·98, 0·95, 0·90

and we find that the said fraction becomes successively

0·933, 0·930, 0·908, 0·839.

This shows that it is sufficient for the two electromotive forces acting on the two secondary spirals to have one from the other a difference of 1, 2, 5, 10 per cent. to cause the proportion of the external utilisable energy to the total energy to decline 6·7, 7, 9, 16 below its maximum value.

If, as in the experiments executed with the electrometer or with the calorimeter the energy produced in the secondary circuit is valued by deduction from that evolved in the external circuit, which alone is capable of measurement, the coefficient of yield must be found reduced in the proportion of X to x.

As the calculation which we have made refers to the case of continuous currents, we cannot assert that effectively the loss of useful effect which may take place in the secondary generator by reason of an inequality in the conditions of the induced spirals will have exactly the numerical values which we have estimated; but the considerations given show that such losses may in some cases be considerable.

And as the secondary generators are especially intended to act connected in quantity, the considerations referred to must be taken seriously into account in the construction and the use of such apparatus.

If the differences between the electromotive forces acting on the secondary spirals connected in quantity may be considerable, it may also happen that to the given result of the decrease of the coefficient of yield may also be added that, still more grave, of a production of heat in the interior of the apparatus which may interfere with its duration and the regularity of its working.

Probably the best way to avoid such inconveniences will be to abstain from placing many secondary spirals upon one and the same column, and instead to connect in quantity distinct secondary generators in which the most perfect equality practically attainable may be aimed at.

(*To be continued.*)

ON THE CHANGES PRODUCED BY MAGNETISATION IN THE LENGTH OF RODS OF IRON, STEEL, AND NICKEL.*

By SHELFORD BIDWELL, M.A., LL.B.

IN order that the results of Joule and Mayer might be comparable with those obtained by the author, he made an attempt to estimate the magnetising forces with which they worked. From data contained in their paper, it was calculated that the strongest magnetising force used by Joule was about 126 units, while the strongest used by Mayer did not on the highest probable estimate exceed 118 units. In the author's experiments the magnetising force was carried up to about 312 units. The metal rods, too, were much smaller than any which had been before used for the purpose, ranging in diameter from 1·40 to 6·25 mm. Their length was in every case 100 mm., and the apparatus was capable of measuring with tolerable certainty an elongation or retraction equal to a ten-millionth part of this length.

By using thinner iron rods and greater magnetising forces than those previously employed, the following curious and interesting fact was established. If the magnetisation be carried beyond a certain critical point, the consequent elongation, instead of remaining stationary at a maximum, becomes diminished, the diminution increasing with the magnetising force. If the force is sufficiently increased, a point is arrived at where the original length of the rod is totally unaffected by magnetisation; and if the magnetisation be carried still further, the original length of the rod will be reduced. It also appeared that the position of the critical point in steel depended in a very remarkable manner upon the hardness or temper of the metal; considerable light is thus thrown on the apparently anomalous results obtained by Joule and by Mayer. Further experiments disclosed strong reason for believing that the value of the critical magnetising force in a thin iron rod was greatly reduced by stretching; this would explain the fact that Joule obtained opposite effects with stretched and unstretched wires.

By ascertaining the relative values of the temporary moments induced by gradually increasing external magnetising forces, an attempt was made to connect the point of maximum elongation with a definite phase of the magnetisation of the several rods in which the elongation had been observed.

Though more experiments must be made before it is possible to generalise from them with perfect safety, the results so far obtained by the author indicate the laws given below. The elongations and magnetisations referred to are temporary only; before the beginning of an experiment the rod was permanently magnetised by passing through the magnetising coil a current equal to the strongest subsequently used. In iron the greatest elongation due to permanent magnetisation was generally found to be about one-third of the total elongation, while in nickel the permanent retraction amounted only to about one twenty-fifth part of the whole.

I.—IRON.

1. The length of an iron rod is increased by magnetisation up to a certain critical value of the magnetising force, when a maximum elongation is reached.

2. If the critical value of the magnetising force is exceeded, the elongation is diminished until with a sufficiently powerful magnetising force the original length of the rod is unaffected, and if the force is still further increased the rod undergoes retraction. Shortly after the critical point is passed, the elongation diminishes in proportion as the magnetising force increases. The greatest actual retraction hitherto observed was equal to about half the maximum elongation, but there was no indication of a limit, and a stronger magnetising force would have produced further retraction.

3. The value of the external magnetising force corresponding to maximum elongation is, for a given rod, approximately equal to twice its value at the "turning point."

Definition.—The turning point in the magnetisation of an iron bar is reached when the temporary moment begins to increase less rapidly than the external magnetising force.

4. The external force corresponding to the point of maximum elongation increases (when the quality of the iron is the same) with the diameter of the rod. So also does its value at the turning point.

5. The amount of the maximum elongation appears to vary inversely as the square root of the diameter of the rod, when the quality of the iron is the same.

6. The turning point, and therefore presumably the point of maximum elongation, occurs with a smaller magnetising force when the rod is stretched than when it is unstretched.

II.—STEEL.

7. In soft steel magnetisation produces elongation, which, as in the case of iron, increases up to a certain value of the magnetising force, and afterwards diminishes. The maximum elongation is less than in iron, and the rate of diminution after the maximum is passed is also less.

8. The critical value of the magnetising force for a steel rod diminishes with increasing hardness up to a certain point, corresponding to a yellow temper; after which it increases, and with very hard steel becomes very high. There is therefore a critical degree of hardness for which the critical magnetising force is a minimum; in steel of a yellow temper the value of the critical magnetising force is lower than in steel which is either softer or harder.

9. In soft steel a strong magnetising force subsequently diminished may cause a greater temporary elongation than the diminished force is capable of producing if applied in the first place.

10. A temporary elongation when once produced in soft steel may be maintained by a magnetising force which is itself too small to originate any perceptible elongation.

III.—NICKEL.

11. Nickel continues to retract with magnetising forces far exceeding those which produce the maximum elongation of iron. The greatest observed retraction of nickel is more than three times the maximum observed elongation of iron, and the limit has not yet been reached.

12. A nickel wire stretched by a weight undergoes retraction when magnetised.

*Abstract of paper read at the Meeting of the Royal Society, April 23rd, 1885.

ON THE SUPPRESSION OF THE NITROUS VAPOURS OF THE BUNSEN BATTERY AND ON A NEW BATTERY WHICH IS DEPOLARISED BY AIR.

By M. A. D'ARSONVAL.

THE suppression of the nitrous vapours in the Bunsen element has occupied many inventors. In a recent memoir M. A. Dupré proposes to add to the nitric acid bichromate of potash for this purpose. This remark was already made by Ruhmkorff, who communicated it to me personally in 1869. The celebrated constructor never omitted indicating this receipt to his clients, and one of them, M. Ernest Saint-Edme, even published it in the following terms in 1871:—

"M. Ruhmkorff has indicated a process for neutralising the emanations of hyponitric vapours. This process consists in filtering the nitric acid over crystals of bichromate of potash. The electromotive force is not affected, and the emanations cease."

I have often employed this method, which answers very well during the first hours, especially if a very intense current is not required.

The nitrous vapours reappear, though less abundantly, as the battery goes on working. This is quite intelligible: as long as chromic acid exists it oxidises the vapours until it is converted into nitrate of chrome. From that moment the battery acts like one with dilute nitric acid.

The salt of chrome derived from the reduction of the chromic acid does not act by absorbing the binoxide of nitrogen, this property belonging exclusively, as Peligot has shown, to the salts of the protoxide. By substituting nitric acid for sulphuric acid in Poggendorff's mixture the coefficient of polarisation of the

liquid is decreased. Further, the presence of nitric acid presents the double inconvenience of giving off acid vapours and attacking the zinc when the circuit is open, which is not the case with Poggendorff's liquid (bichromate and sulphuric acid), especially if we adopt Füller's arrangement (zinc at the centre, dipping into a little mercury). Batteries of this kind are absolutely inodorous, and act very little when the circuit is open, especially if we take care to purify the sulphuric acid with oil as I have indicated.

In 1880, during the researches cited below, I employed for the suppression of the nitrous vapours a method very efficacious, though scarcely practical, for which reason I have not mentioned it in my memoir.

This method consists in adding urea to the nitric acid. In presence of the nitrous vapours the urea is decomposed; nitrogen and carbonic acid escape, while ammonia and water combine with the excess of nitric acid. The same effect is produced if the nitric acid is diluted with urine. In this case the decomposition, in consequence of the presence of mucus, is attended with a great quantity of froth, but the suppression of the nitrous vapours is as absolute as with pure urea.

The principal inconvenience of Bunsen's battery from an industrial point of view lies not so much in the nitrous vapours given off as in the real waste of nitric acid which it occasions. In a series of researches on batteries I showed that the Bunsen element only utilises for depolarisation about 130 grms. per kilo. of acid, and that the mean weight of the acid expended reaches tenfold the zinc consumed when the battery is required to perform its maximum work. I have indicated for this purpose various means, which have become industrial, for utilising in depolarisation all the nitric acid, and suppressing almost completely the nitrous fumes. For the details I refer to *La Lumière Electrique* (Recherches sur les piles, 1881).

In all batteries with a depolarising agent this is the expensive part; the zinc only plays a relatively insignificant part in the cost of such apparatus.

I have made several attempts to obtain from the air, by an indirect method, a depolariser which costs nothing—*i. e.*, oxygen. The following process has so far given the best results: in a flat Bunsen element I substitute for the nitric acid surrounding the carbon a solution of bichloride of copper in hydrochloric acid. With an open circuit the element has an electromotive force of 1·5 volt. On closing the circuit we obtain a current of 8 to 12 ampères with the flat element of Ruhmkorff's model. The solution of copper is dissolved, the copper is deposited on the carbon, but it does not remain there. In presence of the hydrochloric acid and the air it redissolves almost instantaneously. The re-solution can be rendered more rapid by increasing the surface of the carbon, or by blowing air into the porous vessel.

We see that in this arrangement the chloride of copper is constantly regenerated, and that the real depolariser is the oxygen of the air.

The author gives this process merely to "take date," and promises further particulars.—*Comptes Rendus.*

LAWS OF MAGNETIC ATTRACTION.

IN the REVIEW for April 25th we published the results of some experiments gathered from the columns of an American contemporary, in which Mr. W. B. Cooper endeavoured to show that the law of attraction of horseshoe magnets departs from that of *inversely as the square of the distance*, in proportion as the armatures *fail to evoke the maximum force of the magnet.* These experiments the President of the New York Electrical Society, Dr. P. H. Van der Weyde, has criticised at some length, and we reproduce his interesting comments in their entirety. He speaks thus:—

Without attempting to settle this much-disputed problem, I may be allowed to make a few critical remarks upon some principles which should be kept in view when making deductions from such experiments.

It is a geometrical truth that the surfaces of spheres are proportional to the squares of the radii; consequently force, or action proceeding from a centre equally in all directions, must be diffused over the surfaces in the same proportion, and equal parts of surface take on spheres of different dimensions, must receive actions in the inverse ratio of square of the radii, or distances from the acting centre. That means that a surface of, say, a square inch, on a sphere of one foot radius, will be acted upon by the force in its centre with a four times greater intensity than it acts upon a square inch on a sphere of two feet radius, and nine times as strong as it is on every square inch of a spherical surface of three feet radius, &c. Consequently, the total amount of action received by the whole surface of each sphere is equal, whatever be its dimensions, provided the action proceeding from the centre is the same.

This is the case with light. The illumination obtained by any object is inversely proportional to the square of the distance. It is the same with gravitation, provided the central action proceeds from a point, or the distance in question is large enough to consider the dimensions of the acting centre comparatively as a point, without an error of any practical importance. When this is not the case—for instance, when making photometric experiments with a large flat gas flame, at distances, say, only three or four times the width of the flame—the law of inverse squares does not hold. Of this anyone who possesses the facilities for experimenting in this line may satisfy himself.

This, now, is exactly the case with the magnetic experiments reported. The various distances differ only $\frac{1}{10}$th of an inch, while the active parts are by no means points, but lines of nearly one inch in length when the armature is used on edge, or surfaces of almost a square inch when used flat. If such a large surface acts at so small a distance, it cannot be expected that the law of inverse squares could possibly hold, as this is only the case when the distances are so large that the dimensions of the acting centre may be disregarded.

This was the basis upon which Mayce and Martin conducted their experiments. They found that the true law of magnetic force is identical with that of gravitation, namely, inversely proportioned to the square of the distances. They experimented by observing magnetised needles, measuring the angles of deflection at different distances, always large compared with the pole of the magnet. Lambert showed, further, that the force was directly proportional to the magnetic intensity (which depends upon the number of particles magnetised), while it was inversely proportional to the squares of the distances. If here, for magnetic intensity, we substitute mass, we have the identical law as that which prevails in universal gravitation, of which magnetic attraction is only a special and peculiar modification.

Another geometrical truth is that the curved surfaces of cylinders are proportional to their radii simply, and not to their squares, as is the case with spheres; consequently, force, or action proceeding from the whole length of the line of the axis towards the curved surfaces, must be diffused over these surfaces in the same proportion; and equal parts of the curved surfaces of cylinders, of different dimensions, must receive actions in the inverse ratio of the radii. That means that a curved surface of, say, one square inch, on a cylinder of one foot radius, will be acted upon by the linear central force with twice the intensity of that received by a square inch of surface of a cylinder of two feet radius, and three times as much as a square inch on a cylinder of three feet radius, &c. Consequently, the total amount of action received by the whole curved surface of all cylinders, whatever be their radii, is equal, provided the action proceeding from the linear axis is the same.

This is the case with light when it proceeds from a linear luminous body. This, by the way, is the reason

that the incandescent electric lamp has, for small distances, a better carrying capacity than a small arc light of the same luminosity, which latter is the nearest approach we have to a luminous mathematical point, and therefore absolutely follows the law of the inverse squares; while the incandescent lamps, especially those with a long, straight filament, like the large Edison lamps, approach the law of the simple inverse distances, as long as these distances are only such as are common in rooms of moderate use. By twisting the filaments so as to diminish the total outline and concentrate the light in a smaller space, they approach to some extent the law of the inverse squares, and their carrying capacity is impeded.

The mutual action upon one another of wires carrying electric currents, and of linear conductors in general, follow the laws of simple inverse distance, and not of the squares, as was demonstrated by Ampère, when he showed that currents running in the same direction will attract one another, and running in opposite directions they will repel, and this always in the simple inverse ratio of the distance.

According to what has been shown, these facts and the laws deduced from them, are simply a result of the mathematical truth teaching the difference between the geometrical relations of spherical surfaces to their centres, and cylindrical surfaces to their axes.

There is still another consideration which, in the experiments recorded, appears to have been wholly overlooked. It is that the insertion of two, three or four slips of cardboard of $\frac{1}{60}$th inch each in thickness, and used for the separation of the armature from the poles of the magnet, does by no means represent a two, three or four-fold distance from the attracting mass, for the simple reason that the magnetism does not reside on the surface of the pole, but in the mass of the steel, so that the centre of attraction is situated at a certain depth, perhaps surpassing the thickness of several cardboards. If we call the depth n, the real distance of the armature from the centre of magnetic attraction obtained by the insertion of the slips of cardboard are represented by $n + 1$, $n + 2$, $n + 3$, &c.; and applying this to the results recorded, we may attempt to determine the value of n, or we may test whether the simple inverse distances, their squares, as found by Major, their cube, as inferred by Newton, or their sesqui-duplicate ratio, as asserted by Hawksbee, are correct; or if perhaps old Musschenbroch was right, who, by researches, was led to the conclusion that no assignable proportion exists between the magnetic force and distances.

TAYLOR'S TELEPHONE.

ON the evening of April 22nd, Mr. Theo. F. Taylor read a paper before the New York Electrical Society on an instrument devised by himself, and dependent for its action upon the influence of electric currents upon each other. The inventor said he should demonstrate to his audience that his receiver was about equal in loudness to the best modern magneto apparatus, and that its articulation was superior to any yet heard. We made some researches in this direction a few years ago, and we therefore incline to the opinion that Mr. Taylor has set an exaggerated value on the practicability of the idea. It is very well known that those electro-motors whose motion is effected by the action of currents upon one another give the least efficiency of all, it being apparently necessary that magnetic masses should be employed. The same principle applies also to the telephone; but we will let Mr. Taylor tell his own story.

My first effort in the line of telephonic invention was made several years ago, when it occurred to me that a receiver might be constructed on the principle of the attraction and repulsion of currents.

In the text books the attraction and repulsion of currents is treated under the head of electro-dynamics, and under this is understood the laws of electricity in a state of motion, or the action of electric currents upon each other and upon magnets, while electrostatics deals with the laws of electricity in a state of rest.

After some study I made my first model, and tried it in connection with an ordinary Blake transmitter.

The model consisted of two confronting flat coils of fine copper wire, cemented to two hard rubber discs, and held in a wooden case; but not obtaining satisfactory results with an induced current, I laid this model aside.

My next connection with the subject was when I was requested as an expert to investigate the researches of Phillip Reis—to construct and operate the instruments described by him.

I will here remark that at the time I began this investigation I was but slightly acquainted with the history of the telephone and the claims of rival inventors. But such knowledge as I had led me to suppose that the inventions and publications of Reis had but little relation to the invention of the modern telephone.

I constructed all the forms of transmitters and receivers described by Reis and succeeded in making them all transmit and receive articulate speech. The lectures and papers of Reis prove him to be the original inventor of the telephone. He was not only the inventor—he fully understood the principles of their operation and construction. He imparted his knowledge to others in the plainest language. He invented a name for his instruments. He called them "The Telephone." My feelings are strong on this subject, because I am not only indebted to Reis for instruction in the art, but it was one of his transmitters that first made my receiver talk. It has been the fashion to belittle the inventions of Reis, for the reason that they failed to become of any commercial value under his hands. He was looking for scientific and not financial success. I have never heard the great discoveries of Newton belittled, for the reason that he failed to apply for a patent on gravitation.

My experience with Reis's instruments made me familiar with battery transmitters, and on connecting one with my old model I heard it talk and was encouraged to develop it.

In explaining my invention I cannot do better than quote from my application for a patent:—

"My invention is based on the well known fact that electric currents when they are caused to traverse neighbouring parallel conductors in the same direction exert upon each other an attractive force, and when in opposite directions a repulsive force; and the degree with which they so attract or repel is dependent upon the proximity of the conductors and the strengths of the currents.

"When, therefore, the positions of the conductors are approximately constant, the variations in force may be considered as depending upon the variations in strength.

"Parallel results are obtained when an electric current is caused to pass through a single electric conductor in proximity to a continuation of itself.

"Upon this principle the invention is essentially based, and it consists generally in so disposing an electric conductor that different portions of its length are brought into proximity to each other, and a current of electricity caused to traverse the same will pass and repass in approximately parallel directions or in opposite directions through such different portions."

Without further explaining the principles upon which my receiver is supposed to work, I will describe in a few words some of my early experiments.

My first model consisted of two flat coils of fine wire cemented to hard rubber discs. To demonstrate the principle I then procured an old violin, and stretched two fine steel music wires of No. 26 gauge ever the bridge, and made the connections so that the current traversed the wires in the same direction.

Upon using a quantity current I found this instrument reproduced speech, although faintly. I then

cemented a flat coil to an ordinary butter dish about two inches in diameter, also to glass and mica plates. Another form was made by cementing wire inside a thin glass tumbler. All these forms of receiver gave results more or less satisfactory. When a mass of iron was brought near any of these receivers the sound was reinforced. When one of the coils was placed upon an ordinary flat-iron the volume of sound was more than doubled. A coil was cemented to an iron disc, and the result was encouraging. Then two coils were cemented to iron discs which were fastened in a wooden case. This made an excellent receiver.

The attraction between these coils is quite strong.

One form of receiver was made of iron wire in flat coils and responded to induced currents. Another form was made of both iron and copper wire laid parallel and made into a flat coil. This was not very good. I sought to increase the volume of sound by using large discs, but the voice sounded muffled and indistinct. My best form of receiver is now made as follows:—Within a suitable case are supported two plates or discs $2\frac{3}{4}$ inches in diameter, which may be of metal similar to the diaphragms usually employed in the well known forms of telephones, or they may be constructed of paper, vulcanised fibre, glass, mica, wood, porcelain, or other suitable resonant material. One of the plates is perforated at its centre. The plates are separated by a thin ring of hard rubber. Upon the confronting surfaces of the two plates are placed two flat coils of No. 36 copper wire, fastened by shellac varnish, and they are connected with each other in such a way that a current of electricity entering one terminal will pass through the coils in succession, and through the convolutions of the same in parallel directions.

While a steady current is flowing the two coils and plates will be attracted toward each other, by reason of the attractive force exerted by the two broad streams flowing in the same direction.

In action this attractive force is variable by reason of the variations in the strength of the current, which are caused by the action of the transmitter. These variations cause vibrations on the part of the receiving instrument capable of producing sound waves or sonorous vibrations corresponding to those by means of which the current vibrations were originally occasioned.

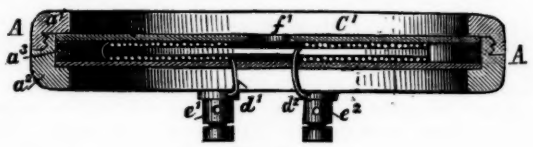


FIG. 1.

In fig. 1,* A represents a case of hard rubber for supporting the several parts of the instrument. This case is constructed in the form of a wide ring in two sections, a^1 and a^2, adapted to be screwed together as shown. Within the case, A, are supported two plates, formed of metal. One of these plates, C^1, is perforated at its centre, as shown at f^1. The plates are separated a slight distance from each other by means of an intervening ring, a^3. Upon the confronting surfaces of the two diaphragms are cemented two flat spiral coils of wire, as shown.

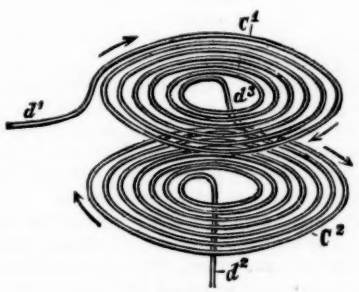


FIG. 2.

In figs. 2* and 3* two different methods of connecting the spiral coils are illustrated. According to the plan illustrated in fig. 2, the current is caused to enter at the terminal, d^1, and to pass in the direction indicated by the arrows from the exterior to the interior convolution of the spiral coil, c^1, the direction in each convolution being parallel to the direction in the neighbouring convolutions. From the interior convolution the current passes through the connecting portion, d^3, to the outer convolution of the spiral coil, c^2, and in the direction indicated by the arrows through its several convolutions to the terminal, d^2. It will be seen thus that the current is caused to traverse both conductors in parallel directions, and the two spiral coils will be attracted toward each other by reason of the attractive force exerted by the current upon itself in the several portions of the conductor.

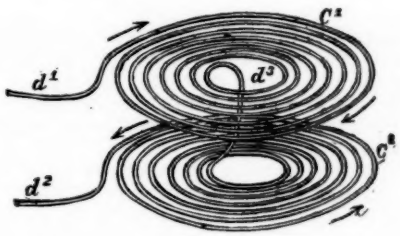


FIG. 3.

In fig. 3 an organisation is illustrated in which the connections of the two spiral coils are so changed that the current is caused to traverse the same in opposite directions; from the interior convolution of the spiral coil, c^1, passes directly to the interior convolution of the spiral coil, c^2, and thence to its outer convolution. The relative directions are thus reversed. The operation of such an instrument is precisely similar to that described in connection with fig. 2, with the exception that the variations in the repulsive force of the two currents are here availed of, in so far as the two spirals may act upon each other, instead of the like variations in the attractive force. The results obtained are, however, essentially the same in either case.

A Hughes microphone with four contacts is used for a transmitter, and on ordinary circuits, say up to two miles, four cells of Fuller battery are used at each end.

On a thirty-mile circuit, measuring 400 ohms, twelve cells are necessary, in fact, the battery is increased according to the resistance of the circuit, and as the percentage of variation at the transmitter decreases.

* Reproduced from the *Electrical World*.

THE ELECTRIC LIGHT FOR WAR SHIPS.

THE Italian cruiser *Giovanni Bausan*, built and armed by Sir W. E. Armstrong, Mitchell & Co., Newcastle-on-Tyne, and commanded by H.R.H. the Duke of Genoa, left the Tyne on her official speed trial on the 11th inst., and during a prolonged trip of over six hours' duration, maintained the exceedingly high mean speed of considerably over $17\frac{1}{2}$ knots per hour.

The vessel which, with her powerful armament of Armstrong guns and torpedoes, is probably the most redoubtable cruiser in existence, is fitted throughout with the electric light.

Two gramme dynamos driven direct by Brotherhood 3-cylinder engines, supply the required current, and

together with 32 1-H.P. secondary batteries, manufactured expressly for ships' use by the Electrical Power Storage Company, and enclosed in teak boxes instead of the usual glass cells, are placed in the after torpedo chamber, where are also fitted an ammeter, a voltmeter, and a switch-board controlling the connections between the dynamos and accumulators and also the *nine* distinct circuits into which the electric lamps are divided.

The incandescent light circuits, seven in number, are as follows :—

	Lamps.
A. Passages, deck-houses and captain's cabins	44
B. Cabins and mess rooms	45
C. Coal bunkers	19
D. Engine room	21
E. Stoke holds, fan rooms, and hydraulic engine room	29
F. Torpedo room	7
G. Magazines and steering gear	11

making up a total of 176 lamps, all of which are of the Edison 8-C.P. 51 volt pattern.

In addition to the division of these lamps into seven circuits at the switch-board, all the cabin lamps are fitted with individual switches.

The ship is also fitted with two search arc lights, of 20,000 C.P., placed on the forward and after gun loading stations respectively.

The ordinary practice on board is to start the dynamos to charge the accumulators during the afternoon, keeping them running during the evening until the cabin lamp circuit is switched off, when the dynamos are stopped, and the accumulators serve to maintain the passage lamps throughout the night.

The accumulators are also employed to maintain a portion of the incandescent lamps when the dynamos are feeding the search lights, and are, moreover, a very useful reserve in case of it being necessary for any reason to stop the engines, or when only one or two lamps are required for any special purpose.

The leads are arranged on the double wire system and are throughout enclosed in wood casing.

The entire fitting up of the installation has been performed by the builders.

SPECTRAL IMAGES IN ROTATING VACUUM TUBES.

AT the conversazione of the Royal Society, Mr. Shelford Bidwell exhibited some revolving vacuum tubes, in which he had noticed a phenomenon which has not, we believe, been hitherto observed. The effect generally noticeable in these apparatus when rapidly revolved is that of a gorgeous star of divers colours, but if such a tube be made to revolve slowly there may be seen, best, we imagine, by persons whose imagination may be termed lively, a spectral image or *ghost*. Mr. Bidwell, in a communication to *Nature*, gives the following description of his curious experiment :—

The tube used in my experiments was 13 inches long, and contained various devices in uranium glass ; the induction coil had a resistance of 1,400 ohms, and was worked by a single large bichromate cell. When the rotation is performed at about the rate of one turn in three seconds, the luminous images of the tube are almost superposed, forming a bunch which is slightly spread out at the ends. But about 40° behind the bunch, and separated from it by an interval of darkness, comes a *ghost*. This ghost is in shape an exact reproduction of the tube ; it is very clearly defined, and distinctly shows every detail of the uranium glass devices. But the colour is entirely changed, the violet tint of the luminous bulb and the bright green fluorescence of the uranium glass being replaced by a uniform steel gray. If the rotation is stopped, the ghost still moves slowly on, and, after the lapse of about half a second, disappears in coalescing with the luminous tube. The phenomenon may be diagrammatically represented by the letter X, the thick stroke being the bunch of luminous images, and the thin stroke the spectral attendant. The direction of the motion is supposed to be opposite to that of the hands of a watch when seen from above. If the rate of rotation is too slow, the ghost approaches the luminous bunch so closely as to be obscured by its superior brilliancy ; while, if it is too fast, the image becomes blurred and ill-defined. The strength of the inducing current should be regulated by trial. With too strong a current the effect is the same as when the rotation is too slow ; with too weak a current the image is rendered feeble. Generally speaking, the best results are obtained with a somewhat weak current.

The experiment has been witnessed by a dozen persons, all of whom, with the exception of one adult, and the doubtful exception of a child, at once saw the spectral image. It is almost ludicrously difficult for those who are able to see it, to understand how anyone else could possibly fail to do so.

This curious effect clearly belongs to the class of spectral images or "ocular spectra," which result from looking at a bright object, persistence of vision in the ordinary sense of the term having nothing to do with it. I proved this to be the case in a very simple manner. The vacuum tube being at rest in a feebly-lighted room, I concentrated my gaze upon a certain small portion of it while the discharge was passing. The current was then interrupted, and the luminous image was almost instantly replaced by a corresponding image which appeared to be intensely black upon a less dark background. After a period which I estimated at from a quarter to half a second (probably more nearly the latter), the black image again became luminous, assuming the characteristic steel gray colour ; this luminous impression lasted but for a small fraction of a second, and the series of phenomena terminated with its disappearance. I found the effect to be most clearly marked when a narrow portion of the tube was observed ; the definition of the spectral image was then exceedingly sharp, even the striæ being represented with perfect distinctness. It was also found desirable to make the preliminary illumination as short as possible, a single flash being generally sufficient to produce the phenomena. This is more easily effected by a judicious manipulation of the contact-breaker than by means of a key, or of the commutator attached to the coil. I may add that it is by no means certain that a person who is altogether new to the subject will at first be able to see the appearances last described, even when he knows exactly what to expect. They belong to a class of phenomena which in ordinary life we habitually train ourselves to disregard, and our persistent neglect makes it difficult to perceive them when we desire to do so. With a little patient attention the difficulty will probably disappear.* It was probably owing to my constant habit of studying visual impressions that the appearance of the ghost attracted my notice in the first instance.

The series of phenomena seem to be due to an affection of the optic nerve which is of an oscillatory character. Abnormal darkness follows as a reaction after the luminosity, and again after abnormal darkness there is a rebound into a feebler luminosity. Following this idea I have endeavoured to detect the existence of a second ghost as the result of a further rebound, but hitherto without success.

It is an interesting fact, as proved by these experiments, that the formation of a spectral image does not occur until the expiration of a measurable interval of time after the exciting cause has ceased to operate.

* The adult who failed to see the ghost is totally unable to perceive the subjective images in complementary colours, which generally result from gazing at brightly-coloured objects. Her general powers of vision are decidedly above the average, and she is in no degree colour-blind. The doubtful child is a daughter of this adult. A younger child can certainly see the phenomenon.

ON THE ELECTRO-CONDUCTIVITY OF SOLID MERCURY AND OF PURE METALS AT LOW TEMPERATURES.

By MM. CAILLETET and BOUTY.

THE electric resistance of pure metals increases with the temperature. According to the experiments of Matthiesen and Benoit (Pogg. Ann. cxv., p. 353, and *Comptes Rendus* lxxvi., p. 342), the mean coefficient of the increase of resistance for a degree of temperature between 0° and 100° differs little for different metals and does not deviate much from $\frac{1}{273}$, *i.e.*, the coefficient of the expansion of gases. If the same law continued to be applicable at low temperatures, the resistance of a metal, varying as does the pressure of a perfect gas at a constant volume, would furnish a measure of the temperature and would vanish at the absolute zero.

We have experimented upon mercury and various other pure metals. The mercury was contained in a capillary glass tube turned spirally and terminating in two wide tubes, into which plunged thick electrodes of amalgamated copper. The reservoir of a hydrogen thermometer penetrated into the interior of the spiral, and the whole was plunged either into ice or into a bath of methyl chloride, or of ethylene cooled by a current of air. When we wished to operate upon another metal, for instance copper, we substituted for the spiral tube a hollow bobbin of wire coiled upon a support of ebonite in which had been made wide apertures so that we could satisfy ourselves of the mixture, of the liquid strata the uniformity of temperature of the bath and the metallic resistance to be measured.

We have used relative measures only. The resistance in question was compared with an invariable resistance formed by a column of mercury at 0° by means of a Wheatstone bridge, and of a very sensitive reflection-galvanometer. The following results have been obtained.

1. *Mercury.*—The empirical formula given by Mascart, de Nerville and Benoit, for the apparent resistance of the mercury in the glass above 0° is applicable down to the temperature of congelation. On solidifying, mercury suddenly becomes more conductive, in a proportion which at — 40° is equal to 4·08. The resistance of the solid mercury then decreases regularly as the temperature falls, and between — 40° and — 92·13° it is accurately represented by the formula

$$r_t = r_{-40} \frac{1 + \alpha t}{1 - 40\,\alpha},$$

in which t represents centigrade temperature with

$$\alpha = 0{\cdot}00407.$$

This coefficient of variation, α, nearly five times greater than that which belongs to liquid mercury, approaches closely that of other pure metals in the solid state.

2. *Silver, aluminium, magnesium, tin.*—For these metals the resistance is represented by the formula

$$r_t = r_0 (1 + \alpha t),$$

and the values of α deduced from numerous experiments executed at different temperatures are the following:

	α	Ranges of Temperature.	
Silver ...	0·00385	+ 29·97°	— 101·75°
Aluminium .	0·00388	+ 27·70	— 90·57°
Magnesium .	0·00390	0	— 88·31°
Tin	0·00424	0	— 85·08°

These values of α, very closely approximating to those which belong to the same metals near 0°, according to Matthiesen's experiments, are for the three first metals almost identical. The value of α for solid mercury falls between the value common to silver, aluminium and mercury, and that which belongs to tin.

3. *Copper.*—The most complete experiments are those which we have made upon copper. We have furnished the following values of α deduced from some thirty experiments, which have been divided into three groups.

	α	Ranges of Temperature.
Copper ...	0·00418	0° to — 58·22°
„ ...	0·00426	— 68·65° to — 101·30°
„ ...	0·00424	—113·08° to — 122·82°

These values of α are a little higher than those which are deduced, in the neighbourhood of 0°, from the formulæ of Matthiesen and Benoit. The variation of the resistance is, moreover, almost absolutely regular, and dispenses, in case of need, with reference to the hydrogen thermometer for the measurement of temperatures between — 20° and — 123°. At this latter point no further appreciable variation of α is to be observed which seems to indicate that the approximate agreement of the hydrogen thermometer, and of the copper spiral thermometer, would extend further.

4. *Iron, platinum.*—These two metals deviate widely from the others by the variation of their resistance above zero, and they deviate in the same direction at lower temperatures. The formula

$$r_t = r_0 (1 + \alpha t) \qquad (2)$$

is suitable for iron from 0° to — 92° with $\alpha = 0{\cdot}0049$, but it is not applicable to platinum. The value of α deduced from the formula (2), which in the neighbourhood of 0° would be about 0·0030, increases, in fact, as the temperature falls and becomes 0·00342 for an inferior limit equal to — 94·57°, thus platinum approximates to the other pure metals as the temperature falls.

In short, our experiments from the electric resistance of most pure metals decreases regularly as the temperature falls from 0° to — 123°, and that the coefficient of variation is approximately the same for all. It appears probable that this resistance would become extremely small, and, in consequence, the conductivity very great at temperatures below — 200°, though our first experiments do not enable us to form a distinct idea of what would take place under such conditions.

We continue these researches, employing the extreme cold obtained by the rapid evaporation of liquified gases.

SUBMARINE CABLE DATA.

WHEN a submarine cable has been manufactured, laid, and officially handed over to a telegraph company, certain details in regard to it are, according to the *Electrical Engineer*, furnished by the manufacturers for the information of the electricians in the service of the company who may afterwards have to deal with it. These details are, as a rule, contained in a printed extract from, or copy of, the ship's log book and the electrical diary which is kept in the testing room on board during the process of laying, and the information to be gleaned from them consists, in its relation to the electrical branch of the subject, of a catalogue of the various types of cable constituting the section or sections which have been laid. In point of fact, we are asked to believe that, practically speaking, the cable is homogeneous throughout — that the short lengths which are put together at the manufactory are identical in every respect, when it is a known fact that this cannot possibly be the case. The short lengths are not only not identical, but differ materially in their capacity, insulation resistance, and conductivity from each other, and it would be somewhat surprising to find electricians accepting as reliable, data which are admittedly incomplete, were it not for the unfortunate fact that they have no alternative. A full and complete record is kept at the workshops of cable manufacturers of the most minute particulars respecting the electrical condition of every knot of cable which leaves their premises, and yet this most valuable and this most necessary information is persistently and purposely withheld from electricians, is treated as a secret

not to be divulged, and, as a matter of fact, kept rigorously out of the hands of those whom it more immediately concerns. Such a thing is an anachronism, and we would suggest that the time has arrived for the directors of submarine cable companies to insist upon being furnished with a full description of the wares they purchase. In the case of broken continuity, where the distance of the fault is to be calculated by discharge, it is a matter of some importance that the capacity of each separate knot of the cable should be known, and this quantity differs almost as widely from that which is obtained by dividing the total capacity of the cable by the length in knots as the insulation resistance of each particular knot does from that obtained by multiplying the absolute insulation resistance by the length of the cable in knots. In the case of a broken conductor the discrepancy is, perhaps, not so great, but in order to show to what extent an error may be introduced by the presumption that the cable is homogeneous throughout, we may cite the Suez-Aden No. 1 section of the Eastern Telegraph Company, which, although in splendid working order, and perhaps in as perfect a condition as when it was laid, is literally patch-worked. That is to say, its seagoing portion is composed of a number of pieces of cable which differ from each other in every respect but that of type. Were the electrician in charge of a repairing operation to be without full information as to these dissimilar sections, the localisation of a fault in this cable would be almost an impossibility. Another thing to which very grave exception should be taken is the inaccuracy of the positions of cables as laid down by the manufacturers on the charts supplied by them on handing over a cable. Where there are no means of taking cross-bearings and sights, a certain element of error in the determination of the position is excusable, and must, indeed, be looked for; but in the case of cables laid along coasts at a distance from the shore which permits of continued observation, inaccuracy can only be the result of carelessness or incompetency. Yet in many instances we have found such cables at distances varying from one and a half to nine knots from the positions laid down on the chart. and, furthermore, within five knots seaward of the cable-house we have found the shore ends of two cables twice overlaid, although the chart showed them to be some three-quarters of a knot apart. As far as we know very little has been said upon this subject, but we hope in the interests of those of our readers who go down to the sea in telegraph ships, and whose duties have reference to the repairing of submarine cables, to see the matter taken up by more powerful pens than our own.

THE ELECTRIC LIGHT IN THE "IRISH TIMES" OFFICE.

AT a meeting of the Royal Dublin Society on Monday evening, Mr. J. A. Fahie, C.E., read an interesting paper on "Notes on a year's working of an electric light installation."

Mr. Fahie said that the installation here referred to is that at the offices of the *Irish Times*, which was fitted up in January, 1884, and has been working continuously under the author's supervision since, so that a year's working was completed in January last. The dynamo-electric machinery consists of a Siemens alternate current machine, and a shunt wound continuous current machine as exciter. These machines are capable of feeding 150 incandescent lamps at a brilliancy of about 17 candles each. The lamps used are of the Swan type, arranged in parallel circuit, and fixed to the gas fittings wherever practicable. The motive power is derived from two gas engines of the Crossley type, which are coupled up to a countershaft from which the dynamos are driven, so that one or other of the engines may be used at pleasure. These engines are each 12 H.P., and are provided with a pair of heavy flywheels to ensure steadiness of motion. The lamps burn remarkably steadily, there being no pulsation whatever visible in the light. The installation is worked on an average eight hours every night throughout the year, except Saturday, and not one working night has been missed since the commencement. The principal portion of the building lighted electrically is the composing room, in which there are about 120 lamps. This apartment, which measures some 60 feet by 40 feet by 70 feet in height, was formerly lit by the same number of gas jets; and, remembering the ill effects arising from the combustion of so large a quantity of gas, especially when we consider the long hours of night during which the work is carried on, it may be readily estimated how extremely unwholesome must have been the air of this apartment. Now, as to the cost of working this installation, which is really the all-important consideration. It must be understood that gas is not wholly superseded; it is partly used in the editorial department, and also in the offices before the electric light machinery is set in motion, as it is not considered economical to start the dynamos until a certain number of the compositors have commenced work. The usual time of starting is about 7 p.m., and the machinery is kept running during the night until three and sometimes four o'clock in the morning, with a pause of half-an-hour at supper time. In summer, however, the light is run continuously during the night, it being desirable to keep the temperature as low as possible. During the twelve months' working a saving of about £120 was effected in the gas account, and this saving covered the interest on the cost of the electrical plant, the breakage of lamps, the wear and tear on the machinery, and the attendant's proportion of wages. These items are made up as follows:—

Attendant's proportion of wages ... ... (The attendant receives 30s. per week; but since he takes the place of a night-watchman, who received 20s. per week, the difference only is charged to electric light account.)		£26	0 0
Oil and waste...		15	0 0
Breakage of lamps—56 at 4s. each ...		11	4 0
Wear of commutator brushes		0	15 0
Repair of gas engines		7	0 0
Repair of driving belts		3	0 0
		£62	19 0
Add interest and depreciation of dynamos —£200 at 15 per cent. ... £30 0 0			
Add depreciation of gas engine —£30 at 10 per cent. ... 30 0 0			
		60	0 0
		£122	19 0

No allowance is made for interest on the cost of gas engine, since, whether the electric light was used or not, the engine would be there for other purposes. This total is, as above stated, covered by the saving on the gas account. What these figures prove, therefore, is that the working of the electric light costs the establishment no more than the lighting by gas for the same period—in other words, the total expense is the same whether the gas is passed through the engines to produce electric light, or direct through the gas burners. Of course there is the vast difference that in the one case the gas is utilised only to drive the engine. and its poisonous elements are discharged into the external air; while, in the other case, the air of the apartments is vitiated to an extent rendering it unwholesome to breathe. If to the above amount we add the cost of the gas consumed in driving the engine, we have the total cost of maintaining the electric light for the year. Thus, the dynamo machinery performed 2,200 hours work during the year, absorbing 19 indicated H.P. This power was obtained at an expenditure of 418 cubic feet of gas per hour (*i.e.*, 22 cubic feet per H.P. per hour).

∴ 418 × 2,200 = 919,600 cubic feet, which at 3s. 9d. per 1,000		£172	8 6
Less 10 per cent.		17	5 0
		£155	3 6
Add amount above quoted		122	19 0
Total cost of electric light		£278	2 6

Recollecting that the motor is gas, and that for *continuous* working *gas* is more expensive than *steam*, the result here shown is certainly favourable to the adoption of the electric light, and demonstrates that, even in isolated installations, it can be worked on terms of financial equality with its older rival. The dynamo machines gave no trouble during the year, and, it will be observed, needed no repairs; and they are now after sixteen months' work in good condition. Considering that the installation was worked for 2,200 hours, it is satisfactory to observe that only 56 lamps were destroyed; of these about 15 were broken through carelessness or by accident, so that only 41 gave way owing to rupture or burning out of the carbon filaments. This, it must be admitted, is a very moderate loss in lamps. The average life of a lamp burning at its normal candle-power is usually estimated at 1,000 hours; but here we have several lamps running considerably longer than 2,000 hours! The long life of the lamp in the present case may be accounted for in two ways: 1st, they are not incandesced to their normal power (being 20-candle lamps and run only at 17 candles); and, secondly, they are worked by alternate current dynamo machinery. It is remarkable to note how considerably the life of a lamp is affected by a difference in the E.M.F. under which it is worked. Taking the actual work done in the installation under notice, and assuming that the average number of lamps run for the 2,200 hours was 130, we find the total cost of working is £278 2s. 6d. This represents a fraction less than a farthing per lamp per hour—just about the same price as an ordinary gas jet burning five cubic feet per hour. From this it follows that the electric light, when used on a moderately large scale, can be maintained, lamp for lamp, at the same cost as gas.

Mr. Fahie, after a discussion had taken place, said he would not advise anyone to touch the electric light who did not require 150 lamps to burn 1,000 hours per annum. In reference to a question, he said that his experience was that compositors' eyesight was considerably improved by the use of the electric light—at all events, their appearance was greatly improved.

NOTES.

The Electric Light in the Royal Navy.—A few days since a distinguished party, consisting of the Duke of Northumberland, the Earl of Mount Edgcumb, Colonel Liddell, and other gentlemen, paid a visit to Devonport. Having embarked on board the gunboat *Scourge* at Cremyll, they witnessed a number of experiments with the electric light on board the *Defiance*, torpedo school of instruction ship, which were carried out under the supervision of Commander Norcock, assisted by other officers. Amongst other experiments a telephone was attached to the apparatus of a diver who, whilst under water, kept up a continual conversation with those on board to the great satisfaction of the visitors, who expressed the pleasure which they felt at what they had seen.

Consequent on the recent war preparations there has been considerable activity in the electric shops in the various dockyards, and the orders issued by the Admiralty have of late been on an unprecedented scale. All the large vessels of war which have been fitting out for sea at Portsmouth are supplied with electric search lights, which are considered absolutely necessary in these days of torpedo warfare; whilst alterations have been made in the apparatus on board several ships in order to include the latest improvements.

Lighting of a Pleasure Yacht.—In a novel pleasure yacht built by Messrs. Hanna, Donald and Wilson, Paisley, the hull of which is made of steel, and the frames, beams and plating galvanised, the cabins are fitted with the electric light, while she is also provided with a submarine and fishing lamp of 500 candle-power.

The Leeds Electric Lighting.—It augurs ill for electric lighting that the matter of the installation in the new Municipal Buildings should have become a subject for litigation. On which side the grievance, if such there be, exists, remains to be seen; but we are firmly inclined to the opinion that in such a case contractors generally would use every effort to set matters straight, if their shortcomings—assuming for the sake of argument that errors had been made—were fairly brought before them. The Leeds affair, however, so far as we are able to judge, savours more of personal feeling than of a matter of business between contractors and an important corporation. One rotten apple will contaminate a heap, and it will take many successful installations to rub out the ill effects produced by a single case which is productive of a law suit.

Regulating the Electric Light.—In our article last week on the electric lighting installation at Sydenham, we mentioned the theatre in Westwood House. The stage and its accessories are, of course, illumined by incandescent electric lamps, and it is important for scenic effects that the turning down of the lights should be gradual, and not by a series of jerks. To effect this purpose, Mr. Aug. Littleton has introduced into the circuit a liquid resistance. A wooden trough is filled with sulphate of zinc, in which are two zinc plates, one fixed at one end of the trough, the other movable by means of screw gearing worked by hand. By manipulating the movable plate the regulation of the lamps is effected in a manner absolutely perfect, and at a cost of but a few shillings. Why is not this system adopted in those of our public theatres which are now employing the electric light? The cost of German silver wire, or even of iron, for the necessary resistances, together with the contact slabs, must run into a considerable sum of money.

The Life of Incandescent Lamps.—Our readers doubtless noticed in the REVIEW last week a reproduction of a telegram dated from Philadelphia, purporting to give some particulars of the incandescent lamp tests. From this, if true, it would appear that at the end of 300 hours the lamps of various makers gave way in the following proportion:—Woodhouse and Rawson, 50 per cent.; Weston, 55 per cent.; Stanley, 60 per cent., and Edison only 5 per cent. No particulars are yet to hand respecting the electrical constants of the lamps, but it is quite possible that some were worked at a lower candle-power than the rest, and that those which appear above to be indifferent specimens will show the greatest economy in the consumption of electrical energy per candle-power.

The Colchester Electric Lighting Scheme.—The manager of the South-Eastern Brush Electric Light Company has forwarded us a copy of a testimonial received from a consumer in Colchester. It was sent voluntarily and shows at least an appreciation of the light which had been supplied from the B.T.K. secondary batteries for a period of eight months.

[COPY.]

Head Offices, Colchester,
Geo. Offor, Esq., *May* 16*th*, 1885.
68*a*, Cowcross Street, London, E.C.

Dear Sir—I can fully express my satisfaction with the electric light, which has been in use in my offices, 36, Head Street, about eight months. There are 19 lamps in use and the light given by them is very satisfactory, especially with the use of the shades, funnel shape, to them. Our rooms are free from a close, stuffy air and are very much cleaner than if we had used gas. All my staff of clerks like the light to do their work by. We have a switch fixed in each office, which is lighted up only when required.

Yours truly, (Signed) THOS. MAY.

The Cruto Incandescence Lamp. — This lamp, of which we gave the working constants in our last week's issue, does not appear to be so very economical at the ordinary luminosity of 20 candle-power, for it consumes at least $3\frac{1}{3}$ watts per candle. If its durability is not very much greater than those of Swan and Woodhouse and Rawson, we fail to see why Mr. Girolamo should consider it as distinguished above all others.

Anglo-American Brush Shares.—The *Times* money article on Thursday stated that there had been some inquiry for Brush shares in the market on the previous day.

United Telephone Shares.—During Wednesday, the shares of the United Telephone Company rose $\frac{3}{8}$ to $12\frac{1}{8}$.

A Wonderful Telephone. — The *Financial News* hears "of a new telephone which has been brought over here from America, and by means of which it is claimed that a conversation can be carried on conveniently between London and Paris, and even between London and New York." Our contemporary is of opinion that "this must be heard to be believed."

The Portsmouth Telephone Exchange.—The decision arrived at by the Committee of the House of Commons, with reference to telephone wires, has given the greatest satisfaction to the promoters of this Exchange. At Portsmouth there are no facilities whatever for the laying of underground wires, and, therefore, had it been decided to prohibit the erection of overhead wires, the commercial men of the town would have been deprived of the advantages for intercommunication which they have recently acquired; unless, indeed, they were prepared to pay exorbitant subscriptions. In extending its wires the company has hitherto found some difficulty in dissuading persons who objected to standards, &c., being fixed to their roofs, and, in many cases, it has been obliged to adopt circuitous routes, entailing thereby considerable expense; but now that it is within its power to carry wires wherever it is necessary much time will be saved in connecting persons who have intimated their intention of becoming subscribers. Up to the present the Exchange has not been so well supported as might have been expected, many of the smaller tradesmen deferring their subscriptions until more members have joined. However, most of the leading tradesmen have been connected with the Exchange, and after Mr. Sandy, the local manager of the Telephone Company, has succeeded in getting about one hundred to join, he will find that as many again will soon avail themselves of the facilities offered for intercommunication. Perhaps an impetus would be given to the undertaking were the company to offer similar inducements to subscribers as have been proffered at Plymouth, where arrangements have been made for members being connected with the theatre and other places of amusement on specified occasions.

Telephone Litigation in America.—In the case of the American Bell Telephone Company against the Clay Commercial Telephone Company, pending the final argument on June 1st, an order has been issued by the Court restraining the defendants until that date. This has the effect of silencing over 800 instruments operated by the Clay Exchange in Philadelphia.

New Telephones.—In our "City Notes" columns we print a circular which has been forwarded to us by the secretary of the New Telephone Company. The instruments there mentioned were fully described and illustrated in the REVIEW for April 25th and May 9th of the present year. We are glad to see that these long talked of instruments are at last coming before the public, and, with such guarantees as the company offers to customers, we can scarcely doubt that its successful operation will be ensured in spite of probable opposition from, and even litigation with, the existing monopoly.

Sixpenny Telegrams.—Extensive preparations are being made by the Government for the new system of sixpenny telegrams. The extensions have been made on the basis of an estimate that the reduction in tariff will cause an increase of the business of the department to the extent of 30 per cent. within the first year, and the extra expenditure already incurred amounts to half a million sterling. Of this amount £475,000 has been spent on new plant—poles, wires, instruments, &c.—whilst £25,000 has been laid out in the erection of new buildings. This comparatively small proportion for the latter purpose is due to the fact that accommodation for future development had already been provided in most of the post-offices built or extended within the last two or three years, including those at London, Manchester, Bradford, York, Exeter and Plymouth, Glasgow and Aberdeen, Cardiff, Dublin, Belfast and Cork. The length of public road upon which new poles have been erected in England is 850 miles, apart from the extension on railway routes, and upon these poles there have been placed 9,200 miles of new wires, in addition to which there are about 11,600 miles of new wires put up on existing road or railway poles. Three new trunk lines have been formed, the first from London *via* Peterborough, Doncaster, York and Pierce Bridge (Darlington), to Newcastle; the second from London, *via* Aylesbury, Widnes, Leamington, then north of Birmingham to the west of Chester, half way between Liverpool and Manchester, through Wigan, and then by way of Lancaster to Carlisle; the third over the South-Western line to Basingstoke, through Andover and Salisbury to Exeter—each with branches at various points from the main circuits. Similar extensions on a somewhat smaller scale have been made in Scotland and Ireland. A number of new three-wire submarine cables, for service under channels, rivers, and lakes, have also been provided for the convenience of the Isle of Man and the Orkney and Shetland Islands. In London, the number of offices at which the pressure of business is met by the use of pneumatic tubes, will be increased by the use of an additional length of 7,500 yards of tube. Among the additional instruments purchased are 40 Wheatstone automatic, eight quadruplex, 300 duplex sounders, 350 single sounders, 150 single needle instruments, and 10 extra repeaters. The duplex system will be completed in the case of 100 circuits. The staff throughout the Kingdom will be increased to the extent of 1,200 new telegraphists and over 1,000 messengers.

In the House of Commons on Tuesday, Lord J. Manners asked the Postmaster-General whether it was intended to take the second reading of the Telegraph Acts Amendment Bill on Friday. Mr. Shaw-Lefevre said he was indisposed to do anything to inconvenience the noble lord, but he would venture to suggest that his amendment was one which could be more suitably discussed on the committee stage. That stage could be taken at some early and convenient day after Whitsuntide, and he would suggest that the House might allow the second reading to be carried on Friday. Subsequently, Lord J. Manners said he had considered the proposal made to him by the Postmaster-General, and not deeming Friday next would afford a suitable opportunity for calling attention to the subject of free addresses, he had no course but to accept the alternative proposal and give notice to postpone his amendment until going into committee.

Telegraphic Communication with Lighthouses.—In reply to Mr. Vivian, in the House of Commons on Tuesday, Mr. Chamberlain said that the experiments in the connection of outlying lighthouses with the mainland by electric telegraph were to be made for a year, from December to December, and as soon as the year was over he expected to receive a report, which he should lay upon the table.

Telegraph Revenue.—The receipts upon the telegraph service from April 1st to May 16th, 1885, amounted to £210,000, an exactly similar amount having been received from April 1st to May 17th, 1884.

Rapid Telegraphy.—The verdict of the jury against Burton and Cunningham, the dynamite conspirators, was published in New York by the United Press Association of America at 10.16 a.m. on Monday (American time), *i.e.*, within six minutes of its announcement in court, the actual time occupied by the Direct United States Cable Company in cabling the message being only 20 sec. The sentence was transmitted by the same company in 18 sec.

Telegraphing from Moving Trains.—Upon this subject the New York *Electrical Review* remarks:—Willoughby Smith, it seems, only last year read a paper before the Society of Telegraph Engineers on the possibility of telegraphing on railroad trains by means of induction. That other Smith, who carries two W's and lives out in Kansas City, suggested that possibility to the writer hereof more than four years since, and has, moreover, an acknowledgement of the fact, about four years old, signed by an official in the Patent Office. One W. is good, but in this case two are better than one.

The Telegraph and Russian War Preparations.—The *Times* correspondent at St. Petersburg states that a telegraph and heliograph detachment has been formed in the sapper battalion of Turkestan.

Repair of the South African Cable.—The Eastern Telegraph Company announces the repair of the Eastern and South African Company's Zanzibar-Mozambique cable, thus re-establishing telegraphic communication with the East Coast of Africa, Natal, and the Cape of Good Hope.

Atlantic Cable Notes.—According to a financial contemporary, there are rumours of an early reduction in transatlantic cable rates.

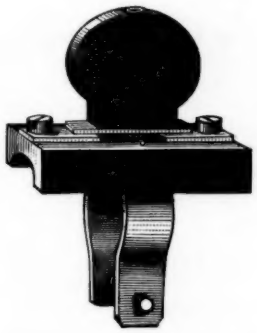
Fatal Accident to a Telegraph Lineman.—A verdict of accidental death was returned by the jury in the case of Henry Bennett, of Honiton, who died from injuries received by falling from a high ladder whilst engaged in his duties with a telegraph working party between Honiton and Chard on May 1st.

The Submarine Telegraph Cables Bill.—In the House of Lords on the 12th inst., upon the motion for the second reading of this Bill, the Earl of Camperdown desired to know what steps the other Powers who were parties to the convention on which this Bill was based had taken to carry out the object of the convention. The Bill provided that persons injuring submarine cables should be tried by the tribunals of the country under whose flag the ship on which they were was sailing. What would take place in the case of war where one of the belligerents tore up a cable which was being extensively used by the other belligerent? Lord Sudeley said the law at present with regard to submarine cables was certainly in a most unsatisfactory condition, and it was to remedy this that the convention had been held. He could not then state exactly what had been done by the other Powers to obtain the necessary measures from their respective Legislatures for carrying out the convention; but he would answer this and the other question of the noble earl on the committee stage. The Bill was read a second time.

Greenwich Time for Paisley.—Some time ago, it will be remembered, communication was established between the large A. Clark Town Hall clock and the observatory on Oakshaw Hill, by which the working of the clock was controlled so that Greenwich time was always given to the public. It was also stated that this timepiece was an exceptionally good one, keeping time very accurately. The wire connecting the two has broken twice, and it is now proposed to use a thicker one and carry it in a more roundabout direction, in order to have more support than the old one, which had a long stretch from the High Church to the Town Hall without any rest.

Electricity and Torpedoes.—A *Times* telegram from Constantinople states that the Turkish Military Department continues to devote attention to the torpedo defences of the Bosphorus and Dardanelles. A series of experiments is being carried out with a view to providing a certain means of closing those channels by the use of the electro-automatic contact maker, under control from the shore.

Temporary Switch for Electric Lighting.—The cut shows a handy little apparatus devised by Mr. Baker, of Smith, Baker & Co. Manchester, for the Manchester Edison Company. It is intended for attachment to



ordinary gas brackets, to the pipes of which it is easily screwed. We think the sketch is so self-explanatory that we need say nothing further on the matter.

Electric Wires.—Users of wire for telegraphic, tele phonic, electric light and other similar purposes will find what they want plainly described in the neatly-arranged trade list of the London Electric Wire Company, of Golden Lane, E.C., a copy of which is before us.

The Working of Gas Engines.—In the interesting paper contributed by Mr. Fahie to the Royal Dublin Society, the indicated horse-power of the gas motor is given as 19 H.P., taking 22 cubic feet of gas per horse-power hour. This represents an actual brake result of about 14¼ H.P. with a consumption of 30 cubic feet of gas per horse-power hour. It will be noticed that the price of gas in Dublin is 3s. 9d. per 1,000 cubic feet, whilst in some parts of the metropolis it may be obtained at as low a rate as 2s. 10d. For the same sum, therefore, expended in London, some 25 per cent. more lamps could be employed than appears to be the case in Dublin, although, according to Mr. Fahie's statement, here or in Ireland the cost would be the same for a similar installation, whether the gas be burnt direct or turned into motive power for driving dynamo machinery. Had the lamps been incandesced to 20 candle-power, the light obtained from a given quantity of gas would have been greater by the second method of consumption, but probably this would have been at the expense of a shorter life for lamps. We have hitherto been under the impression that for an installation of such a character as is fitted in the office of the *Irish Times* a considerable increase of light may be obtained from gas utilised as a motive power instead of burning it in the ordinary way. Perhaps some of our readers may have facts in their possession respecting this, which would materially assist the development of electric lighting through the medium of gas engines used as prime movers.

Economical Glow Lamps of Moderate Luminosity.—We understand that Messrs. Woodhouse and Rawson are now supplying 10-candle power lamps requiring an E.M.F. of 100 volts, and a current of but 0·25 ampère. This shows a marked advance in lamps of such moderate candle power, and we should be glad to know if any of our readers can supply data relative to the life of these, or of the 95 volt 20-candle power lamps by the same makers.

Electrical Tram Cars.—On Monday evening, Mr. C. E. Spagnoletti in the Chair, a paper "On Electric Tram Cars" was read by Mr. A. Reckenzaun at the Inventors' Institute. The author said that whilst a single electric tram car only existed in this country, a paper on the subject might be thought premature. This solitary example is, however, the latest and only practical form; and the Institute has the privilege before other societies of judging of the merits of an invention, as an invention, apart from commercial aspects. An interesting discussion followed, in which Prof. Geo. Forbes, Mr. Traill, Mr. Drake, Mr. Shoolbred and others took part, the improvements made by Mr. Reckenzaun being thoroughly recognised.

Consumption of Electrical Energy in Glow Lamps.—In a letter from the pen of Mr. Fredholm we notice the following interesting fact: In one instance there is generated 20,900 watts to supply 350 Edison 16 candle-power lamps, and in the second case 12,000 watts for 300 Woodhouse and Rawson lamps of 20 candle power each. Neglecting the resistances of leads &c., which may be assumed as being the same in each instance, we have in one case a consumption of 60 watts per lamp, or just upon four watts per candle, and, on the other hand, 40 watts per lamp or one candle for the expenditure of two watts. Can there actually be such a marked difference as that which is here apparent, or is it not more probable that the lamps in the latter instance were over-running their normal candle power, for we do not think that Messrs. Woodhouse and Rawson yet lay claim to quite such economy as is here shown?

The College of Science and Arts, Glasgow.—A Glasgow contemporary writes:—"The success which has attended the College of Science and Arts in Bath Street since its guidance came under its present principal, Mr. Jamieson, was never better seen than it is this year. Over 1,000 students were enrolled for the various classes in connection with the college, and the diversity of the subjects taught shows the good work which is being done. The number of students who have come forward for the science and art examination this week is about 600, while there are about 120 who are in for the examination in connection with the London City Guilds."

The Arc Light Scores a Victory.—Several years ago, when the voltaic arc light first made its appearance in the streets of New York, we said in these columns (New York *Electrical Review*) that, if given a fair trial, the public would refuse to have any other. Year by year the number of these lights have been increased, until now the city authorities have determined to spread them over all the principal thoroughfares. It has been decided to continue the electric lights in streets in which they are now in operation, and to award contracts for 20 such lamps in Canal Street between Bowery and the North River, for eight in Catharine Street, for 18 in Fulton Street between the North and East Rivers, and 10 in Chambers Street between Broadway and the North River. Each new electric light is to take the place of five gas lamps. Each electric light is to cost the city 70 cents per night.

The Experiments at Creil.—According to *Engineering*, contradictory reports are in circulation regarding the actual date of M. Marcel Deprez's experiments on the transmission of power electrically from Creil to Paris. It is believed that the insulation of the wires in the dynamos has proved insufficient to resist the high tension currents generated, and the insulation of other parts of the machines is also imperfect.

Value of the Ohm.—At a recent meeting of the American National Academy of Sciences, Prof. Rowland gave the value of the ohm, as corrected by his own experiments, as equal to 106·2 centimetres of mercury one millimetre square.

Edison on the Warpath.—A slight ripple of excitement was caused yesterday, says the New York *Herald* of May 3rd, among people interested in electric lighting by the news that suits had been begun in the United States Circuit Court, in this city, by the Edison Electric Light Company against various alleged infringers of Edison's patents for incandescent electric lighting, and also against a number of representative users of the alleged infringements. Among the infringers are the United States Electric Lighting Company, the United States Illuminating Company, the Consolidated Electric Light Company, the Swan Incandescent Electric Light Company, the Remington Electric Light Company and the Schuyler Electric Light Company. The users of infringements selected are the Union Club, the directors of the Park Bank, the directors of the United Bank and the Providence and Stonington Steamship Company. Mr. Edison, in his complaint, claims that he is the inventor of the devices for incandescent electric lighting described, that his patents cover all the fundamental principles of that system, and that a long, careful and exhaustive investigation of his claim has been made by the High Court of Berlin, in Germany, with the result of a decree in his favour. To a reporter of the *Herald* the president and secretary of the United States Electric Lighting Company said that they had heard, incidentally, that papers in Mr. Edison's suit had been served upon the company's counsel. They did know, however, that the United States Electric Lighting Company began several suits, in the United States Circuit Court, in this city, against the Edison companies, for infringement of patents of Edward Weston, Moses G. Farmer and Hiram S. Maxim, on dynamo-electric machines, regulators, incandescent lamps and safety devices. Mr. Curtis, the secretary, further said that the suits were part of a long continued patent litigation instituted by Mr. Edison some years ago. The public would not sustain any inconvenience during the progress of these suits, for it only concerned certain apparatus. The question which the Court would finally determine was, who had the rights in the patents and who should pay the royalties.

Universal Wire Coupling.—Perhaps the most ingenious little article that has come under our notice for some time is the "Universal Wire Coupling," of which we give an illustration. It was, we are informed, originally invented for use in laboratory work, where the coupling up of wires for testing purposes is very frequent; but we are inclined to believe that it adapts itself to many other requirements, such, for instance, as joining up electric light wires in an installation, connecting the wires of dynamo machines, &c.

The slots come up to a slant, so that the wires are not cut at all. The finest gauge wire is firmly gripped, and good contact is secured. For permanent work the nuts may be soldered, or supplied with a lock nut. When used as a battery terminal it would be a great advance on the old form, where the contact is often more or less indifferent. The couplings are manufactured by Messrs. Davis and Timmins (Limited), and Mr. H. C. Harold, of 30 and 31, St. Swithin's Lane, E.C., has, we understand, the sole right of sale for them in this country.

The Society of Telegraph Engineers and Electricians.—At the next meeting (at the Institution of Civil Engineers, 25, Great George Street), to take place on Thursday, May 28th, the papers submitted will be—"Ship Lighting by Glow Lamps, embodying results of trial for economy in H.M.S. *Colossus*," by B. J. Farquharson, Member; and "Electric Lighting at the Forth Bridge Works," by J. N. Shoolbred, B.A., M.Inst. C.E., Member.

Scientific Visitors at Bristol.—The members of the London Physical Society, in response to an invitation from the chemical and physical sections of the local Naturalists' Society, have paid a visit to Bristol, during which they examined at the University College Mr. Jolin's interesting contrivance for ringing a series of electric bells on the same circuit at the same time.

Lightning Strokes.—We have received a copy, in pamphlet form, of a paper "On the Mechanical Characteristics of Lightning Strokes," by Col. the Hon. Arthur Parnell, taken from the Quarterly Journal of the Royal Meteorological Society. Our readers are already aware of the somewhat peculiar views with regard to lightning strokes entertained by Col. Parnell.

Rodgers' Patent Pulleys.—These pulleys are used exclusively for driving the electric light machinery at the Inventions Exhibition, as they were for the recent Fisheries and Health Exhibitions. They can also be seen working at the Stand of the Kirkstall Forge Company, No. 130, Group 4, South Gallery, Middle Court.

Electrical Engineering.—We have received a catalogue of the wares of the Æolus Waterspray Ventilating Company, which gives some little attention to the smaller branches of electrical work, the necessities for which are priced.

The Electric Lighting Act.—On Wednesday evening, the Marquis of Salisbury in dealing with public affairs said :—"Mr. Chamberlain has had in his hands a certain industry which at one time seemed promising—viz., that of furnishing electric light to the community. I tell you it is not a large matter ; but you can study the action of laws on small matters as well as large. He was not content to allow it free scope to win its way as best it could. He was not content to trust to the results of free energy and exertion, but he thought he would get ransom, and therefore he procured an enactment in Parliament, that after twenty-one years any enterprise which these electric light companies set up should be confiscated for the benefit of the municipality under which they acted. What was the result ? It shows you how this plan of exacting ransom from property answers. Bankruptcy has followed, I think, every one of those companies, the industries have been absolutely stifled, and an invention which in America is marching on with gigantic strides and contributing largely to the comfort of the population, is here entirely strangled."

Overhead Wires in America.—Secretary Manning, we learn from a New York contemporary, has ordered all electric wires to be taken from the roof of the United States Treasury Building, giving the companies until June 30th to comply.

Abandonment of The Waterloo Electric Railway.—The Unopposed Bill Committee, on Wednesday, passed the Bill which authorises the abandonment of the Charing Cross and Waterloo Electric Railway, sanctioned in 1882. The abandonment of this line has, it is said, been partly brought about owing to the difficulties experienced by the company with the Metropolitan Board of Works.

American Exhibition, London, 1886.—The managers of the American Exhibition have succeeded, says the *Anglo American Times*, in securing the *best* location in London for their enterprise — Earl's Court. The selected site is but a short distance from South Kensington, and situated in the best part of London. The property to be occupied by the exhibition covers about twenty acres, and has railway advantages in advance of any exhibition ever held in London. The station for the District Railway will be in the exhibition grounds, and another one will be at West Brompton, a few steps from the entrance to the main building.

Society of Arts.—The Society of Arts conversazione is to be held at the International Inventions Exhibition on July 3rd.

The British Association.—The arrangements for the next meeting of the British Association at Aberdeen on September 9th next have been all but completed. The president elect this year is Sir Lyon Playfair, who will take the place of Lord Rayleigh, who presided so ably at Montreal last year, and Professor Bonney serves for the last time as acting secretary. The presidents of the various sections are as follows :—A. Mathematical and Physical Science, Professor G. Chrystal ; B. Chemical Science, Professor H. E. Armstrong, of the Central Technical School ; C. Geology, Professor J. W. Judd ; D. Biology, Professor W. C. M'Intosh ; E. Geography, General J. T. Walker, C.B. ; F. Economic Science and Statistics, Professor Henry Sidgwick ; G. Mechanical Science, Mr. Benjamin Baker, M. Inst. C.E. ; H. Anthropology, Mr. Francis Galton, F.R.S., president of the Anthropological Institute.

A Good Time Coming.—From exchanges we learn that Col. Martin, the engineer-in-chief of the Brooklyn Bridge, is contemplating with confidence the abandonment of the cable system there and the increase of traffic that must be the inevitable result of the adoption of electricity for propelling the cars. Meantime official reports of the most damaging character come from Philadelphia, where large sums of money have been spent on a cable road that will not work. Affidavits from some of the leading citizens and scientific men in that city show that the cable conduits are nothing better than open sewers, and that the system itself is, so far, an utter failure. The climatic conditions and the construction of the streets are so much alike in New York and Philadelphia that it is safe to assume that the failure of cable roads in the one city would be matched by a similar experience in the other.

Jablochkoff's New Battery.—A most laudatory article on this new battery—"Auto-accumulator," the inventor calls it—recently appeared in an English journal of the highest repute, and we fear that in some minds considerable misunderstanding, not to say misplaced confidence, in the new idea will result therefrom. So far as we can judge this triple electrode battery is about as valuable a production as the same inventor's electro motor, which is well known as the most inefficient of all which have yet been tried. We shall endeavour in our next issue to show that this apparatus, which is said to produce one horse-power hour of electrical energy for one half-penny, is, if not a retrograde movement, certainly if we do not misunderstand it, no advance in primary batteries.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Railway and Domestic Electric Lighting Company, Limited.—The statutory return of this company, made up to the 18th October, 1884, was filed on the 18th inst. The nominal capital is £6,000 in 60 shares of £100 each, the whole of which have been taken up. A call of £50 per share has been made, the calls paid amounting to £1,150. The sum of £3,600 is considered as paid on 36 shares, and £50 remains unpaid.

An extraordinary general meeting of the company was held at the registered offices of the company, 28, York Street, Westminster, on the 16th February, when it was resolved that each £100 share be divided into ten shares of £10 each ; certain alterations were also made in the articles of association. The resolutions were subsequently confirmed at a meeting held at the same place on the 10th March, and were duly registered on the 12th inst.

Thompson's Electrical Fitting and Screw Cutting Company, Limited.—This company has entered into an agreement, dated 23rd March and filed on the 15th inst., for the purchase from Messrs. Norcliffe, George Thompson, and George Henry Rew, of 77, Turnmill Street, E.C., of the goodwill of their business, lease of

premises, screw making machines, lathes, drilling machines, tapping machines, tools, plant and working appliances. The purchase consideration is 1,000 fully paid shares of £1 each. The company will also purchase the manufactured stock of the vendors at 25 per cent less than their customary invoice or sale price, and all unmanufactured stock at cost price.

NEW COMPANY REGISTERED.

Bullion and Metal Refinery Company, Limited.—Capital: £10,000 in £100 shares. Objects: To purchase from Messrs. Walter Wood and Edward Easton, for fifty fully paid shares and £200 cash, an invention entitled "A new and improved process for separating compounds of metals by electricity," for which provisional protection was granted on the 27th March, 1883, to Mr. Lyman Elmore, acting for Mr. George James Atkins. Letters Patent have also been granted in France and Belgium in respect of the said invention. Signatories: J. Findlater, 33, Wellington Street, Strand, two shares; J. Mansel Brett, 19, Albert Mansions, S.W., one share; A. F. Cornish, C.E., 76, Albert Road, Dalston; Walter Wood, 22, Chancery Lane, one share; Edward Easton, C.E., 11, Delahay Street, S.W., one share; J. A. M. Cope, 3, Great George Street, S.W., one share; J. M. Walters, 6, Gray's Inn Place, two shares. Registered 18th inst., without articles of association, by Messrs. Cope & Co., of 3, Great George Street, Westminster.

LEGAL.

The "Hudson."—(Before Mr. Justice Butt and Trinity Masters, Wednesday.)—This was a case of salvage services rendered by the telegraph cable steamship *Minia*, which left Halifax, Nova Scotia, on the 28th of March for the purpose of repairing the Brest-Saint Pierre cable, which had been broken about lat. 48 34 north, and long. 11 W. The weather was very tempestuous, and on the 8th of April a dismasted barque, which proved to be the *Hudson*, was sighted about seven miles off, flying signals of distress. The course of the *Minia* was altered, and having approached the *Hudson* it was ascertained her main and mizen masts had been carried away close to the deck, her foretop mast had gone at the cap, and she had suffered other serious damage. At the earnest solicitation of the master of the *Hudson*, the captain of the *Minia* agreed to make an attempt to save the barque. Hawsers were then passed between the two vessels, and on the 12th of April the *Minia* brought the *Hudson* safely into Falmouth, having towed her a distance of 490 miles. The value of the *Hudson*, her cargo, and freight, was £17,685. Mr. Justice Butt awarded the salvors £1,500, which he apportioned as follows:—£900 to the owners of the *Minia*, £200 to the captain, and £400 to the crew.

CITY NOTES, REPORTS, MEETINGS, &c.

The River Plate Telephone and Electric Light Company, Limited.

THE third ordinary general meeting was held at the offices of the company, No. 34, Wallbrook, London, E.C., on Tuesday, under the presidency of Mr. John Taylor, chairman of the company, when the following report of the directors for the year ending 31st January, 1885, was submitted:—

"The paying exchange and private wire subscribers in Buenos Ayres and Monte Video, on 31st January, 1884, numbered 1,573, the annual value of the rentals being estimated to be about £27,000. The respective figures on same date this year were 1,845 and £29,226, showing an increase of 272 in the total number of paying subscribers, and £2,226 in the total annual value of rentals.

"The directors consider this shows a satisfactory increase in the company's business for the past year, and they are happy to be able to add that by returns received to 31st March the list of paying subscribers has been raised to 1,885, a proof that the demand for the company's exchanges continues steadily on the increase.

"On the recommendation of the managing director and the manager at Monte Video, several important improvements in the services are now being executed, which it is confidently expected will not only give greater satisfaction to existing subscribers, but will also contribute effectively to extend the business and maintain the high favour in which the Gower-Bell is held in the River Plate Republics.

"The net revenue for the year is £5,803 1s. 2d., but it will be observed that the capital expenditure for the same period amounts to £10,836 10s. 11d. This has only partially been covered by income, and as there is no other source at present from which the growing necessities of the business can be met, the directors regret that they are unable for the moment to recommend any distribution of profits, although the accounts show that the full cumulative dividend on the 9 per cent. preference shares has been earned.

"The interest has been regularly paid on the £20,000 of 9 per cent. debentures, created last year in connection with the settlement of the Consolidated Company's account for supplies. The shareholders are indebted to that company for renewed support, as they figure again for the principal amount due to creditors in the balance sheet.

"The directors have, with the approval of the auditors, written off the total amount of discount and commission incurred by the last two issues of shares:—In that of 1883, £1,504, and that of last year £2,110, together £3,614.

"The £1,000, voted for depreciation of plant at the general meeting held in August of last year, have been placed to reserve fund, together with a further sum of £3,000 for the like purpose, which, in complete concurrence with the views of the auditors, has been deemed necessary.

"Rigid economy in conducting the business of the company, consistent with efficient management, has been the study of your board, and the shareholders will be pleased to learn that in the matter of directors' fees in London and Buenos Ayres a saving of £1,000 per annum has been effected.

"The chairman, having occasion lately to visit the River Plate on other business, availed himself of the opportunity to look into the affairs of this company, and is pleased to report his satisfaction with the manner in which the business is conducted both at Buenos Ayres and Monte Video. The thanks of the shareholders are also due to the members of the local board for their careful supervision.

"The rate of exchange at Buenos Ayres has been seriously depressed since January last in consequence of the suspension of specie payments by the State banks there. As this state of things may last in a more or less aggravated form for some time to come, it has been resolved by the directors, if approved by the local board, to increase the charge to subscribers, with a view to cover any loss by exchange in funds required to be remitted to this country."

The Chairman, in rising to propose the adoption of the report, said there were one or two explanations which it was desirable should be made. In the report they stated that the increase during the year amounted to 272 paying subscribers with an annual total rental of £2,226. They were obliged to take that sum as representing the additional subscription money; but it did not, in fact, really represent that number of subscribers. They had to take that figure because, as they would observe, it coincided with the other figures given. But he had to state to them that in the Monte Videan exchanges they had had to reduce the rates very considerably, causing the subscriptions during the year at that exchange to be nearly £3,000 less than in the previous year. He would also mention that it had been customary to consider private wire subscribers as two subscribers; they had, of course, two instruments. In the year 1883 there was an enormous increase of 573 subscribers, or an estimated increase of income of £10,000. It was not predicted then, nor was it expected, that they would go on increasing at the same rate; but he was happy to say that since the beginning of the present fiscal year the increase had been going steadily on, especially at Buenos Ayres. He thought they would agree with him that the increase, considering the population of the two cities, was most satisfactory; they would be surprised when he told them that the number of subscribers to the telephone exchanges in Buenos Ayres and Monte Video was nearly as great as in the whole City of London. There were about 4,500 in the two cities, and in London the subscribers only numbered 4,700, whilst the population of Buenos Ayres and Monte Video combined was only about one-tenth of that of London. It had been decided to put in magnetos in all the services in Monte Video, and when this and the further improvement of the introduction of female labour had been effected, the manager felt confident of being able again to compete satisfactorily with the opposition. The directors regretted as much as any of them that they were unable to recommend a dividend. Anyone accustomed to accounts would see that they could hardly do so under the present circumstances. The Consolidated Company was a creditor to a large extent, and it would scarcely be honest to raise money to pay a dividend and leave their creditors unpaid; the Consolidated Company would have cause to complain and might withdraw the support it now extended. Another reason which had influenced the directors was the rate of exchange. In January last the State bank suspended payment under a decree from the Government, and the premium on gold since then had risen very considerably. In April it rose as high as 66 and within 24 hours dropped to 47; at present the rate was 38 per cent., a very serious consideration to the company, and on that account alone the Consolidated Company had been very kind to allow their account to stand over. The chairman then proceeded to explain the accounts, and stated that since the present board came into office a saving of £1,000 in directors' fees alone had been effected. He (the chairman) had

paid a visit to the River Plate, and he might say he was very satisfied with what he saw of their affairs there. He was there some three or four months altogether, and he had opportunities of attending all the meetings of the local boards and of inspecting the whole of the exchanges, and he might say that Mr. Powers and those under him deserved great praise indeed for the efficient manner in which they had conducted the exchanges. They worked with the least possible friction, and there could be no question, so far as he could find out, that they gave very much more satisfaction to subscribers both at Buenos Ayres and Monte Video than the opposition.

Sir Alexander Armstrong seconded the motion.

Mr. Pillans remarked that the working expenses amounted to 85 per cent., and asked if there was no prospect of their being reduced.

The Chairman explained that that result was arrived at by including the £1,500 interest on debentures.

Mr. Pillans thought that was part of working expenses. In London the Telephone Company worked at 50 per cent.

The Chairman presumed they did not pay any interest on debentures, and their subscriptions were larger.

A Shareholder said something like £18,000 must fairly be charged to working expenses, and it seemed to him absurd to keep the company going at all. Anyone might see that it was only kept on to pay salaries to work it and fees to direct it. He held in his hand the prospectus under which he subscribed, and its promises had not been carried out in any way.

Mr. R. Clarke could not see the slightest use in carrying the company on. He had been promised a dividend of 9 per cent. regularly, but now for a year and a-half he had received nothing.

Mr. C. L. W. Fitzgerald: Have you taken into consideration the fact that no less than £10,000 has been paid this year? Where do you suppose that £10,000 came from? You have a business, and that business is a growing one. Suppose the shareholders of the L. and N. W. Railway, when their directors asked them for more capital, refused to give it, where would be the extensions of the N. W. Company I should like to know? This is exactly the same question. Here you have a good business without any capital. Where did the £28,000 which the Consolidated Company accepted in debentures come from? Out of the pockets of the shareholders of the Consolidated Company, and not out of yours. When I came into power I could have simply wiped this company out for the debt of £28,000.

Mr. Clarke: That is a matter for the directors, and they should never have allowed it to be possible for you to do so.

After further discussion, the motion was put and carried unanimously.

Sir Alexander Armstrong having been re-elected a director, and Messrs. Deloitte, Dever, Griffiths & Co. auditors,

The Chairman declared the meeting extraordinary, for the purpose explained in the following circular:—

"Your directors find considerable difficulty in carrying on the business of the company satisfactorily in the absence of working capital wherewith to meet the growing requirements attending the steadily increasing number of subscribers.

"There are liabilities already incurred to a considerable amount for capital expenditure, and the only means available at present to meet this outlay is the net profit on revenue, which is thereby locked up for the time being, and not available for dividend.

"To meet this inconvenience the directors now feel it their duty to apply to the shareholders for power to issue further capital at a discount, which power they will make use of as they may deem most advantageous in the interests of the company."

The Chairman moved "That the directors be and they are hereby authorised to issue the whole of the unissued and authorised capital as they may think fit, and to issue shares in satisfaction of the liabilities of the company."

Mr. Fitzgerald seconded the motion, which was carried, the meeting then terminating.

West India and Panama Telegraph Company, Limited.

THE sixteenth ordinary general meeting of this company was held at the City Terminus Hotel, Cannon Street, E.C., on Wednesday, Mr. C. W. Earle presiding. The directors' report for the six months ending 31st December, 1884, which was submitted to the meeting, was published in our last.

Mr. R. T. Brown (the secretary) having read the notice convening the meeting,

The Chairman said the accounts showed a decrease in the gross revenue for the half year of £4,235; but that was in comparison with an abnormal half year, when they had upwards of £5,000 increase, and also a half year of windfalls, one of their repairing ships having been chartered to an American company, and some profit derived in that way. Other details in the report explained the decrease in the present half year: for instance, interest on the reserve fund was carried to the reserve instead of to the credit of revenue, whilst also there were some arrears of subsidies which became payable, and did not appear in the corresponding half year. There was nothing in the working of the concern which effected the falling off in the gross revenue, which was entirely a matter of account. The same state of affairs had influenced the expenditure side of the account. There was an increase in expenditure of £5,400, compared with a period in which there was £6,075 expended less than in the then corresponding period. In the half year ending 1883 the ships were taken off their hands for some time, as far as expenditure was concerned, by the American company, by which one of them was chartered, and they also brought one of the vessels home to be repaired and overhauled, after which it took out a cargo of cable, the freight of which was credited to the ship, thus materially reducing the expenses. There was nothing in the expenditure of the present half year that was at all abnormal, and the business was conducted in very much the same course as before. With regard to the subsidies, when last he addressed them, they were in negotiation with the three colonies, Barbadoes, Guadeloupe, and Martinique, for the renewal of their subsidies. He was now happy to say that this had been effected, Guadeloupe renewing for ten years, Martinique for five years, and Barbadoes for only three years. The renewal of the St. Thomas subsidy had not been settled yet, although it expired on the 31st December last. He met the Governor of that colony when he was in London, and was assured by him that the colony was in a very poor condition as to finances. It appeared that their supremacy as the great shipping port in the West Indies had vanished, the cause being the existence of the telegraph, which had benefitted the other colonies at the expense, in this particular matter, of St. Thomas. The Governor told him he did not think it possible for the colony to continue the same amount of subsidy, and he (the Chairman) anticipated that there would be a diminution of about £200. The colony of Barbadoes still stopped the way of increasing the subsidy. It appeared from what he heard, that what St. Thomas and the other colonies had lost through the establishment of the telegraph had been gained by Barbadoes. But when they complained of the treatment of the colonies, it was well to bear in mind that they were in a very depressed state, and it was even asserted that the treasury of Barbadoes was empty, the Government officials receiving their salaries in driblets. There had been great depression in the sugar market, which, however, seemed now to be partially recovering, the effect of this being seen in their traffic returns, which for the current half year showed an increase of 6 per cent. The Jamaica-Porto Rico cable, laid in 1871, before the present board were in office, which had never been a very effective cable, had been duplicated and repaired. In 1873 the cable between Jamaica and Colon was purchased, and instead of being relaid in the same position as intended, was very fortunately diverted, so as to run between Jamaica and Porto Rico. In 1881 they began seriously to examine and effect repairs in the original Jamaica-Porto Rico cable, and it was only when the ships were not engaged in more important work that they were allowed to proceed with the restoration of that section; after persistent, tiresome and expensive operations the cable was at length restored in October last year, and had worked satisfactorily since. Great credit was due to the officers and crews of the ships who had carried out those repairs during long days under a tropical sun, and amid many difficulties and disappointing circumstances. He then moved, "That the directors' report and accounts to the 31st December, 1884, submitted to this meeting, be and the same are hereby received and adopted; and that, as recommended by the board, a payment of 6s. per share on account of the arrears on 1st preference shares be and the same is hereby declared."

Mr. William Ford, a director, seconded.

Mr. Newton commented on the importance of the restoration of the cable referred to by the chairman, and asked as to its character, remarking that the fact of its having stood so long was a complete answer to those who some years ago tried to impress upon them that cables would only last a very few years.

The Chairman said the directors quite appreciated the value of this restoration; it gave them a duplicate line over the most important part of their system. The quantity of new cable was 232 miles out of a length of 700 miles. The type of the cable with which it was repaired was identically the same as the original cable; all the original cables were sheathed. This particular cable had never been a satisfactory one. He did not mean that there was anything the matter with the construction of it, but it had not been skilfully laid. If the old board had not diverted the Telegraph Construction Company's cable they would have been in great difficulties, for they would have lost connection with the important islands in the West Indies, and would have lost the subsidies and everything else.

A Shareholder asked what the Panama Canal was likely to do for the company when it was opened.

The Chairman said it was very difficult for them to speculate upon that. It would probably be a very long time before it was opened, but in view of the large number of ships that would be attracted to that locality, he could not conceive its not benefitting them when it was opened.

Mr. Baker enquired whether the board had done anything with respect to the overdue interest on coupons on the preference shares. It was time they placed their property in a better position, and he suggested the issue of the second preference shares in payment of the first. He also suggested the re-purchase of the 6 per cent. debentures out of the reserve fund, which was invested at 4 per cent.

The Chairman replied that the 6 per cent. debentures were not due until the end of next year, when no doubt they would be able to make some other arrangement. As to paying them off, he could not see how that was to be done without using the reserve, a course he could not recommend.

Mr. Baker considered the reserve much larger than was really necessary for such short lengths of line as theirs.

The Chairman asserted that the depreciation was to the same extent as in longer lines.

Mr. Baker: It could not possibly cost so much to repair short lengths as longer ones.

The Chairman reminded Mr. Baker that in 1877, when the board recommended a course similar to that now proposed by him, the re-construction of capital and capitalisation of arrears, he was not very favourably disposed towards it—in fact, he caused them some trouble and expense.

A Shareholder asked if the directors would hold out some encouragement by stating their proposed limit to the reserve.

The Chairman said he did not like to commit himself as to the extent to which they were going to continue the reserve. They had a certain basis in their minds formed upon the presumed life of a cable and the rate of interest they could get upon securities of a good class. He might say, however, that in a very short time the annual contributions to the reserve would be considerably lessened. A reserve fund, which was really a depreciation fund, could never be quite closed, because every year there was a fresh depreciation going on.

The resolution for the adoption of the report and declaration of a dividend was then put, and carried unanimously.

Messrs. Earle and Ford were re-elected directors, and in returning thanks, Mr. Ford at some length drew a comparison between the position of the company ten years ago and now, immensely favourable to the present position.

Mr. J. G. Griffiths having been re-appointed auditor to the company, the meeting terminated with a vote of thanks to the chairman.

The Consolidated Telephone Construction and Maintenance Company, Limited.

THE report to be presented at the fourth general meeting of the company is as under:—

The directors beg to lay before the shareholders a statement of accounts and balance sheet for the year ending 31st March, 1885.

It will be seen by the revenue account that the amount standing to the credit of profit and loss is £5,208 18s. 4d., and the directors recommend that this amount be carried forward to the next year's account.

It will be recollected that at the meeting in December, 1884, it was decided to write off to capital account the sum of £7,500 from the balance of revenue account, 1883-84, viz., £10,290 17s. 9d., and the remainder has been written off the valuation of stores on hand on the 31st March, 1884, the amount being considered in excess of their value.

In accordance with the resolution passed at the adjourned general meeting in December, 1884, the capital account has been reduced to £243,787 10s., of which £168,637 10s. is issued, and the same has been sanctioned by the Court of Chancery.

The relations between the United Telephone Company and your company continue of a satisfactory nature.

Your directors are happy to state that the manufacturing business has decidedly increased, and that with the extension of the radius granted by the Postmaster-General to the United Telephone Company and its subsidiary companies, a new life seems to have been given to telephonic enterprise, and considerable orders have been executed for the United Kingdom.

There is on hand at the moment amongst others a most substantial order from the United Telephone Company on behalf of the Postmaster-General.

Sample telephones have recently been submitted to the War Office (for use abroad), to the Postmaster-General of Melbourne, and to the Spanish Government, and good results may be looked for in these quarters.

There is also under the consideration of the board a large order for Canada. The shareholders will read with satisfaction that the "Consolidated" telephone is highly approved by the Canadian Government, which has recently favoured this company with an order; and, also, by the authorities working the Sydney exchange, and in many other places.

In addition to the orders received from your subsidiary companies in Austria, Portugal, and the River Plate, several orders have been received from the Continent, and it is hoped that in course of time these may be greatly extended.

The business of the several subsidiary companies in which this company is largely interested continues to make very satisfactory progress.

The Telephone Company of Austria, at the end of March, 1884, had 575 subscribers, paying a gross annual rental of £3,920. At the end of March, 1885, there were 918 subscribers, representing a gross annual rental of £6,433. This shows an increase of 346 subscribers, and of £2,513 on the annual rental. There also were 264 persons wishing to join the exchanges, with a gross annual rental of about £2,000.

With regard to the Edison-Gower-Bell Telephone Company, at the end of March, 1884, the two exchanges of Lisbon and Oporto had 586 subscribers, paying a gross annual rental of £3,821; and at the end of March, 1885, there were 870 subscribers, paying a gross annual rental of £5,380. This shows an increase of 284 subscribers, and of £1,559 rental during the year.

As to the River Plate Telephone Company, on the 29th February, 1884, the number of subscribers in the exchanges of Buenos Ayres and Monte Video was 1,571, with a gross annual rental of £27,000; and on the 28th February, 1885, there were 1,858 subscribers, paying a gross annual rental of £29,400. This shows an increase of 287 subscribers and £2,400 gross income.

The total increase in the exchanges, as compared with 1884 and 1885, may therefore thus be stated:—

Telephone Company of Austria ...	343 subscribers.	£2,513	rental.
Edison-Gower-Bell Telephone Co.	284 „	1,559	„
River Plate Telephone Co. ...	287 „	2,400	„
Totals	914 „	6,472	„

New Telephone Company, Limited.

THE following circular has been issued by the above company:—

The instruments which this company offers to the public have been invented to meet a widely-expressed desire for telephones which can be purchased outright. As is well known, the present holders of the patents for the forms of instrument covered respectively by the patents of Edison and of Bell, refuse to sell their instruments to the public, but rent them out at high rentals, varying from £15 to £20 per annum. The New Telephone Company, on the contrary, proposes to sell its instruments outright, demanding neither annual rentals nor royalties. It has taken the most careful steps to ascertain, and has been advised by the highest legal authorities, that the instruments which it sells do not in any way infringe either the patent of Edison or that of Bell. The former patent claims a right to use the combination of a tympanum with a tension-regulator in the transmitting part of the instrument, and the latter patent claims the use of a receiving instrument, having a permanent magnet in it, and also claims the use of an iron plate clamped all round at its edge.

None of these things are used in the instruments patented by Professor Silvanus P. Thompson.

In the new transmitting instrument the use of a tympanum to catch the sound of the speakers voice is obviated by the employment of a funnel-shaped tube; and instead of the tension regulator or carbon button used by Edison, there is a metallic ball-valve. This combination of a speaking tube with a ball-valve to control the electric current, is one of the most novel points of the new invention, and is as simple as it is novel.

The receiving instrument at present used by the New Telephone Company is a form of apparatus expressly disclaimed by Bell, though, in the hands of the company's electricians, it proves to be a better and more sensitive instrument than those claimed by Bell. The vibrating diaphragm consists of a piece of gold-beater's skin, properly prepared, carrying at its centre a bit of thin iron about as big as a thumb nail; this is placed in front of an electromagnet of a form which experiment has shown to be peculiarly well adapted for the purpose, and which is excited by current from a battery in the line wire. This combination constitutes a more powerful receiver than any yet placed before the public.

It will thus be seen that the features hitherto claimed as essential by those who desire to restrict the free sale of instruments, are conspicuous by their absence.

The new instruments, though no louder in their talking than those which the public are accustomed to use, are much more distinct in their articulation. They have been in daily use for some months over a long private line, and everything has been done to make the most exhaustive tests of their capabilities.

A form of guarantee by the company against any claim by trade rivals for alleged infringement will be given to the purchaser of any telephone requiring the same, and the company will indemnify the purchaser against any such claim, and defend any action brought.

For private lines between the different departments of a factory, or between the office and the works, and for country houses, the telephones of the New Telephone Company are particularly well adapted.

The price fixed by the New Telephone Company for the two complete sets of instruments required for the two ends of the line is £16; this sum includes one transmitter and two receivers at each end of the line, as well as the call-bells and switches. These figures do not include the cost of the line wires, or the battery cells, which can be procured of any electrical firm, or will be supplied by the company, if desired, at special quotations.

It will thus be seen that the New Telephone Company is prepared to furnish purchasers with a complete set of the newest and best finished instruments at a price about equal to the sum hitherto demanded for a yearly rental.

Under the Telegraph Acts, the purchaser of a telephone can use it for his private purposes, but should he desire to use it for public purposes, he must apply to the Post Office for a license.

Anglo-American Brush Electric Light Corporation, Limited.—Application has been made for settling day and quotation for the further issue of 6,695 fully-paid shares, of which 5,489 (Nos. 40,701—46,189) are issued.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th May, are £3,811, as compared with £3,631 in the corresponding period of 1884; the January receipts estimated at £5,447 realised £5,381.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 15th were £2,141, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, May 14th, Mr. C. E. SPAGNOLETTI, President, in the Chair.

The minutes of the last ordinary general meeting having been read and confirmed, and the list of new, and proposed new, members, announced, the Secretary said that the council had been discussing the subject of Electrical Nomenclature, and had decided to form a committee to consider the question. It was intended that the latter should be a very general one, and it was proposed to invite the assistance of the professors in the various science colleges for the purpose; M. Blavier and M. Hospitalier had also been asked to help in the matter.

A paper on "Electrical Definitions, Nomenclature, and Notation," was then read by Prof. A. JAMIESON, Member. The different modes of expression and symbols used by different authors, and sometimes by the same author, to explain and interpret one and the same thing or result, are very perplexing. All this might be avoided if an international system of definitions, nomenclature, and notation was agreed upon and legalised. The rapidity with which the new definitions of the ohm, ampère and volt (issued and legalised last spring at Paris by the International Congress of Electricians) were universally adopted shows this. These definitions should be still further extended to other electrical units. They should embrace a suitable system of notation, whereby electricians could represent in symbols and letters, terms, expressions, and formulæ of common occurrence, in a similar manner to that adopted by chemists in connection with chemical elements and their combinations. A committee of this society might be formed to consider and draw up a series of definitions, nomenclature and notation that would be generally acceptable. The proposed committee might then confer with the French committee, also with a similar committee appointed by the British Association, and, finally, this important question should be referred to the International Congress of Electricians, in order that they may legalise and issue their decisions in a similar manner to that adopted by them in the case of the ohm, the ampère, and the volt. Undoubtedly, if such a course were adopted, most beneficial results would accrue to all concerned. Only last November M. Hospitalier brought this subject prominently before the International Society of Electricians at Paris, and strongly advocated an investigation. At the very outset students are perplexed by such different terms as "ordinary or static, or frictional or high-tension electricity." The term "accumulator" is the name given in several text-books to apparatus, such as the Leyden jar or condenser, for receiving and retaining quantities of electricity, but has been lately inappropriately applied to secondary batteries, which do not accumulate electricity. "Tension," "potential," and "electromotive force," are terms which, when variously and indiscriminately applied, have given rise to considerable confusion, and a great deal of writing in trying to define them. The words *electromotive force* and *difference of potential* are used frequently one for the other, but they are not, strictly speaking, identical. Electromotive force is the more general term of the two, and includes difference of potential as one of its forms. "Potential" might well be reserved for electro-statics, and "Electromotive force" for electro-kinematics, or current electricity, and thus prevent confusion. The word "electric-pressure" has come into vogue lately, and strongly appeals to those of a mechanical turn of mind, seeing that the hydraulic simile of "head" or "pressure" is often brought forward to assist in explaining the terms "potential" and "electromotive force." In magnetism the same want of uniformity exists. The pole which turns towards the geographical north is variously called the "austral pole," "north pole," "north-seeking pole," "marked pole," and is painted red by Sir Wm. Thomson, while Sir Wm. George Airy, Prof. Guthrie, and others, paint it blue. It is sometimes indicated by French makers by the letter A, and by British by the letter N. Sailors, and some writers on the mariner's compass, call the angle which the magnetic meridian makes with the geographical meridian the "variation" of the compass, while electricians call it the "declination." Sailors also speak of the "deviation" of a compass, meaning by that the local error due to the resultant of the quadrantal, semicircular, and heeling errors. It would be far better if they simply spoke of the "compass error," or angle which the meridian of their compass-needle makes with the true north and south magnetic bearings. When we come to electricity generated by batteries, we find the expressions "galvanism," "voltaic electricity," "dynamic electricity," "electro-kinetics," "current electricity," &c., according to the fancy of the writer or speaker. "Density of current" and "Intensity of current" often cause great confusion. With a little pressure, French electricians would no doubt agree to the symbol C instead of I to promote uniformity. Then I might be reserved for intensity of magnetism, where it suits very well. "Positive electrode," "(+) terminal," "zincode," "anode," "positive pole," and "negative plate," severally used by different writers to designate that end of a cell, battery, or pile where the current leaves, and "negative electrode," "(−) terminal," "platinode," "kathode" or "cathode," "negative pole," "chlorous pole," "positive plate," where the current returns to or enters the same, requires revising and simplifying, more especially when we consider that the end plates of a battery are of opposite sign to their electrodes or terminals, and that the nomenclature is still further complicated when we come to consider secondary batteries or electrolysis by the terms "anion," "kation" or "cation," and "ions." Again, we have the different ways of graphically representing a battery according to the whim or fancy of the writer. Practical submarine electricians always adopted the long thin vertical line for the plate where the current leaves, and the thick short line for the plate where the current returns to the battery. Why should this have been departed from? It is a mere arbitrary arrangement, but, being a most convenient symbol, it should be used in a uniform manner. Mr. John Munro proposes that the symbol for a secondary battery should be a modification of this, viz., a short thin vertical line for the plate where the current enters, and a long thick line for the plate where the current leaves. "Parallel circuit," "multiple arc," "loop circuit," "in loop," "derived circuit," "shunt circuit," are all expressions to signify pretty much the same thing, where one expression, "shunt circuit," would do. "Polarisation" is a term used in many different senses—for example, the polarisation of battery plates, molecular polarisation due to electrification or magnetisation, polarisation of light due to magnetism, &c., as in Dr. Kerr's experiments. Some reform is here required. Coming to telegraphy, telephony, and electric lighting, we find, as M. Hospitalier points out, "the words generator, receiver, transmitter, and motor are mixed up by different inventors." The want of uniformity as regards abbreviations and notation with symbols, and the need of systematising is obvious, but perhaps difficult to accomplish. Every one admits the great advantage in being able to write down the symbols for chemical elements and their actions and reactions one with the other in the form of simple equations, which anyone may comprehend who knows the subject, without a detailed description of what each letter or symbol stands for. Electricians should not rest satisfied until they are supplied with a similar universally-accepted notation, whereby electrical phenomena and actions may be similarly treated.

The author then gave a list of abbreviations, notations, and symbols, which he suggested might with advantage be taken as a basis for general adoption. In the notation the first letter of the most important words has been used wherever it was found practicable to do so, and the recurrence of the same letter under similar circumstances is avoided as much as possible. In cases where no ambiguity can occur, such as H for the heat in Joules, and H for the horizontal intensity of the terrestrial magnetism; m for metre, and m for magnetic strength of pole; V for velocity, and v for volts, the same letters appear in each case.

In the discussion which followed the reading of the paper,

M. E. HOSPITALIER said that the question considered in the paper was one of great importance. A committee of twenty representatives had been formed in France to consider the subject, and six meetings had already been held. In drawing up a system, the symbols, &c., employed should be such as would appeal to the reason, and not the memory only. M. Hospitalier then stated the symbols, &c., which he had proposed should be adopted. In criticising Mr. Jamieson's paper, he pointed out several inconsistencies in the symbols proposed. He considered the use of the *small* Greek omega to represent ohms, and the *large* Greek phi to represent farads, as unsymmetrical. In speaking of Violle's unit of light, he considered it to be much too large, as to continually use sub-multiples only did not look well. The word "unit" he thought to be meaningless, and it required to be changed. The subject of "definitions" would soon be dealt with by the French committee. With regard to the compound symbols suggested by Mr. Jamieson, he said that there would be great difficulty in adopting the same in France, from a printer's point of view.

Prof. FORBES considered that one difficulty in selecting symbols, &c., was the fact that in many cases those suggested to represent the same thing were all equally good. He strongly deprecated theories being brought into the question. He advocated the term "pressure" being used to indicate difference of potential between two contiguous points. With reference to magnetism, he pointed out Sir William Thomson's argument that it was practically impossible to get sailors to grasp the fact that a south pole was one which pointed to the north, and *vice versa*. He thought symbols to express C.G.S. units were wholly unnecessary.

Mr. J. MUNRO thought that graphic symbols might be introduced with advantage, so that in drawings—lamps, dynamos, &c., might be indicated in a manner which would be comprehended by all nationalities.

Prof. AYRTON agreed with Prof. Forbes that symbols should not suggest theories. He did not agree that condensers and accumulators were so very distinct, as they both accumulate *energy*, though in a different way. Electromotive force, he contended, had a meaning distinct from difference of potential, as, for instance, when we spoke of the electromotive force of a battery, which did not necessarily mean the difference of potential between its poles. He had found it very convenient in practice to use capital letters to express resistances, and small letters to express the current flowing through those resistances.

Mr. HARRISON thought an objection to Prof. Ayrton's last suggestion was the fact that the alphabet would soon be run through if it were adopted.

Mr. SHOOLBRED, Prof. SILVANUS THOMPSON, Mr. BIGGS, and Dr. FLEMING also took part in the discussion.

Prof. JAMIESON having briefly replied, the meeting adjourned.

NEW PATENTS—1885.

5879. "Electric generators and electric lamps." W. P. THOMPSON. (Communicated by T. Elcoate.) Dated May 13.

5944. "Signalling by electricity." E. B. BRIGHT. Dated May 14.

5990. "Making telegraph poles." D. WILSON. Dated May 15.

6037. "Electro-motors and dynamo machines." M. IMMISCH. Dated May 16.

6038. "Electro mechanical means for regulating the speed of electro-motors, increasing and decreasing electric currents gradually." M. IMMISCH. Dated May 16.

6041. "Method of suspending electric lamps." A. C. HENDERSON. (Communicated by P. E. Jullien.) Dated May 16.

6042. "Methods of generating electric currents and the apparatus whereby the same is effected." R. H. COURTENAY. Dated May 16.

6067. "Electric drilling machines." S. A. HOUGHTON. Dated May 18.

6082. "Primary dry galvanic battery cell." F. WALKER, C. SMITH. Dated May 18.

6088. "Galvanic batteries." E. B. BURR. Dated May 18.

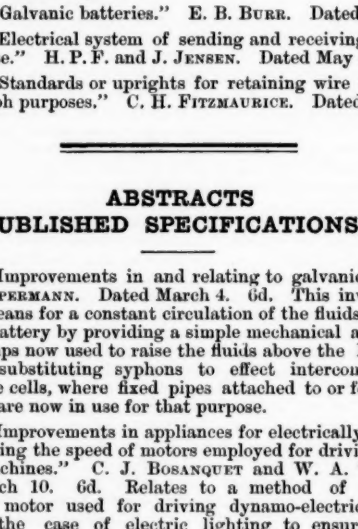
6118. "Electrical system of sending and receiving signals for domestic use." H. P. F. and J. JENSEN. Dated May 19.

6131. "Standards or uprights for retaining wire in positions for telegraph purposes." C. H. FITZMAURICE. Dated May 19.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

4382. "Improvements in and relating to galvanic batteries." C. J. D. OPPERMANN. Dated March 4. 6d. This invention supplies the means for a constant circulation of the fluids in a series of cells or battery by providing a simple mechanical arrangement for the pumps now used to raise the fluids above the level in the cells, and substituting syphons to effect intercommunication between the cells, where fixed pipes attached to or forming part of the cells are now in use for that purpose.

4665. "Improvements in appliances for electrically controlling and regulating the speed of motors employed for driving dynamo-electric machines." C. J. BOSANQUET and W. A. TOMLINSON. Dated March 10. 6d. Relates to a method of electrically regulating motor used for driving dynamo-electric machines, so as in the case of electric lighting to ensure as far as possible the maintainance of a constant current in the lamps, independent of the number of lamps burning, of one or



more lamps being stopped or renewed, or any other outside cause; by means of gearing rotated by the main shaft of the motor, and brought into action by the aid of solenoids, or electro magnets and solenoids. The said gearing, in accordance with the invention, increases and decreases (as required) the rate of expansion; or opens and closes (as required) the valve used to control the speed of the motor. The apparatus is so constructed that when the current of the dynamo is at its normal electromotive force the gearing is out of action; but immediately the electromotive force rises above the normal, the gearing is brought into action by the solenoids, or by the solenoids and electro magnets, and the speed of the motor is thereby reduced. The reverse of this takes place upon the electromotive force falling below the normal. Provision is also made in this invention for bringing the motor automatically to rest should the main circuit be accidentally or otherwise broken. The fig. illustrates the "regulator" caused to act by a solenoid and two magnets. A solenoid, A, is here used to pass the current to one or other of the magnets, B and C, which bring gearing into action. When variations occur in the strength of current through lights being turned on or off, or any other cause, the solenoid brings governor into action, to effect the required adjustment of throttle valve, or other equivalent part of motor. If strength of current exceeds the normal, the current passes through magnet, C, which, by gearing partly closes the valve; and when the current falls below the normal, magnet B opens the valve. The governor is driven from horizontal shaft D, E being the driving pulley. The shaft, D, carries a sleeve with a gear wheel at each end, F and G. This sleeve rotates with shaft, D, but is capable of motion along same, enabling one or other of the wheels, F and G, to gear with a third wheel, H (preferably friction gearing or toothed gearing with friction clutches, but a suitable equivalent may be used), which wheel, H, has its spindle in connection with the throttle valve. This connection may be made in any suitable manner, but preferably by bell crank lever, *h*, actuated by screwed spindle of wheel, H. A shunt from main circuit of dynamo circulates in the solenoid, A, and the pull on the core, I, in normal position is balanced by a spring or weight, S, and any variation in strength of current causes the core, I, to rise or fall, and bring the lever, K, in contact with one of the contacts, L or M, closing a before open shunt circuit through one or other of the electro magnets, B or C, as the case may be. Upon the strength of current falling below normal the lever, K, makes contact with the wires, N, O, exciting magnet, B, which attracts the lever, P, and brings wheel, F, in gear with wheel, H, and opens valve. Upon the strength of current rising above normal, the core, I, rises, and with it the level, K, and makes contact between the wires, N, R, exciting magnet, C, which attracts lever, P, and brings wheel, G, in gear with wheel, H, and closes valve. In cases where this arrangement of governor is inclined to hurt the fulcrum of lever, K is on the valve spindle, or so connected that it has a similar motion to that of the valve spindle communicated to it, so that the valve, in changing its position, breaks contract between lever, K, and either of the contracts, L or M, as the case may be, releasing gearing before the valve has travelled too far. A magnet, T, and weighted lever, V, are added for the purpose of closing the valve in the event of the current breaking. The magnet, T, is excited by a small portion of current from dynamo, and while current lasts holds the weighted lever, V, but immediately the current breaks, the lever, V, falls, forcing shaft, W, and lever, P, to the left, which brings wheels, G, H, into gear, and closes valve. Z is a spring to keep shaft, W, in position, and is compressed when lever, V, falls.

4898. "Improved bell, dome, gong, or alarum for telegraphic, telephonic, and like purposes." G. WATTS. Dated March 14. 4d. Fig. 1 shows a section of the apparatus with the inversion,

FIG. 1.

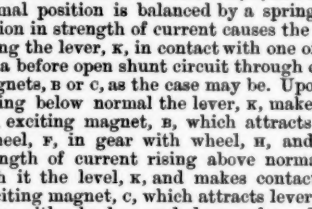
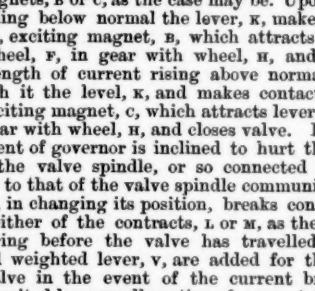


FIG. 2.



A, forming the standard, B, with a screw or other fastening, C. Fig. 2 also shows a section of the apparatus cast solid at the top, A, and forming the standard, B, with a screw cast at the base of the standard, C.

5304. "Improvements in the manufacture of electrodes for primary or galvanic electric batteries." T. ROWAN. Dated March 22. 4d. The inventor employs iron, copper, manganese, silver, lead, or other suitable metal in a cellular, spongy or porous state, or in a state of division, which material is built up or formed into suitable plates or electrodes in which is preferably employed an inoxidisable base or support, either as plain sheets or ribbons, or a series of them, or as perforated or ribbed plates or sheets, which extend throughout the electrode, or are arranged or formed in such a manner as to constitute an envelope for the same, and these electrodes are provided with extensions or terminals preferably moulded upon, or permanently and intimately secured to or with the inoxidisable parts of the electrode by fusion or otherwise.

6414. "Improvements in apparatus for the extraction of metals from their haloïd compounds by means of electrolysis." L. A.

GROTH. (Communicated from abroad by R. Grätzel, of Hanover.) Dated April 16. 6d. Relates to improvements in the apparatus described in provisional specification lodged with the application for Patent No. 551 on the 3rd January, 1884, by which the arrangement is altered by carrying the negative electrode through the insulating vessel, which is or may be in this case quite open at the bottom.

6770. "Improved means for measuring electric currents." H. ARON. Dated April 24. 6d. Consists in securing a magnet to the pendulum of a clock and making said rod swing above or within an electric coil, so that this coil will either attract or repel the swinging magnet and, thereby, either increase or reduce the natural attraction of the earth on the pendulum. In consequence the electro-magnetic influence exercised by the coil upon the pendulum will either accelerate or retard the motion of the clock-work, and the dial will show a time fast or slow compared with that of a normal clock. Such deviations of the clock influenced by the electric current, from the true motion of a normal clock afford the scale for measuring the influence, by which said deviation has been occasioned, and in case of the magnetic influence being small compared with the gravitation of the pendulum, the deviation will be also in proper proportion to the time, within which the magnetic influence has been working, as also in due proportion to the intensity of the current, and accordingly the arrangement will constitute a coulombmeter. Instead of applying the electro-magnetic influence to one clock only, and of comparing the deviations of this clock with the true time of a normal clock, the inventor may employ two clocks influenced by the same current, one of which clocks is made to go as much fast as the other is going slow; the difference between the indications of the two dials affords the scale for measuring the quantity of electricity supplied, each of these two clocks consuming only one half of the magnetic influence. This mode of counting will afford even a greater proportionality to the quantity of electricity to be measured.

6908. "Improvements in electro-magnetic apparatus adapted to the generation of electric currents for exercising and other hygienic purposes." H. J. ALLISON. (Communicated from abroad by J. H. Shaw, of America.) Dated April 28. 6d. Consists in the combination with a rheophore dumb-bell or device which encloses the electro-magnetic battery and inductorium, and which is provided with suitable external manual contact and conducting plates and binding-screws or connections for electrode wires of a separate electrode in the form of a dumb-bell, or other manual exercising device also provided with external manual contact-plates and binding-screws or connections for a conducting wire, and of a conducting wire adapted to connect the rheophore dumb-bell with said electrode dumb-bell, and to close an electrical circuit from the former through the latter and through the hands and body of the person holding in either hand the rheophore and the electrode.

7185. "Improvements in dynamo-electric machines." E. JONES. Dated May 3. 6d. The improved electric machine has only a single shaft bearing, the driving pulley being keyed to one end of the shaft and the armature and commutator to the other end thereof. The field magnets are formed with pole pieces at one end only, and the armature rotates between one or more pairs of these pole pieces, the shanks or cores of the field magnets being arranged parallel to the armature shaft. One end plate or standard serves to carry the single bearing for the armature spindle and the shanks or cores of the field magnets, and by this arrangement free access to the armature end of the machine can be had.

7212. "An electrical registering tell-tale, also applicable for indicating an earth on an electric circuit." P. JOLIN. Dated May 5. 6d. Situated in each place to be visited by the watchman is an instrument of the following construction:—Mounted on a suitable frame or plate is an electro-magnet, made preferably with two bobbins, and having an armature attached to the frame by a spring or other means, but normally held away from the electro-magnet. A projection is formed on the armature on which may rest one end of a lever, the other end of which is pivoted to the frame or plate. Under the lever is placed, free to turn on a suitable stud, a metal block, one end of which is a long wedge, the other end is a shorter wedge, or is rounded. On the front of this wedge-block is a projection against which a key, which is turned on the stud, presses, the projection, when the key is turned, also raising the lever before mentioned on to the projection on the armature. Under the wedge-shaped block is placed another wedge piece, fixed to a spring attached to the frame. The wedges are so arranged that the block cannot remain in a position that will not allow of the free fall of the lever when the armature is attracted. Pressing against the lever when at its highest point, but insulated from the frame, is a contact piece, or spring, which is free from the lever when the latter is released by the armature. The connections are so arranged that when the lever is touching the contact piece the circuit is complete, but on the armature being attracted the lever is released, and falls free of the spring, breaking the circuit, unless other contact pieces are used, as follows:—Attached to the frame and insulated therefrom is a second contact piece, and suitably attached to the armature is a third contact piece, which, when the armature is attracted, rests on the second contact piece, and when so resting the circuit is arranged so that the whole or part of the wire on one or both bobbins is short circuited, and the circuit through the instrument not broken until the breaking at the master instrument. The whole instrument is fixed in a lock-up box, and the keyhole covered with a suitable substance held in a frame, so arranged that when the frame is pushed into place with the substance in it the box cannot be opened without destroying the said substance. A flag or piece of metal, painted one or more colours, is attached to the lever to show through a hole in the box when the lever has been raised.

7312. "Improvements in microphones." K. S. DEMBINSKI. Dated May 6. 6d. Relates to improvements in the apparatus described in the No. of the REVIEW for June 7th, 1884.

7315. "Improvements in apparatus for conducting a current of electricity to or from a train in motion." J. ENRIGHT. Dated May 6. 4d. Consists in making the upper surface of a contact post metallic and smooth, and in fixing a series of springs to the under surface of a long insulated conductor on the train, so that as the train passes one of these springs at least may touch the contact post.

7375. "Improvements in apparatus for facilitating the use of electric currents for telegraphic purposes." R. K. BOYLE. Dated May 7. 8d. Consists essentially in providing means whereby a vibratory or undulatory motion may be imparted to a wire or wires (that is to say, one for each line wire), stretched between two standards or supports, and passing between the jaws or pole-extensions of a large locally excited electro-magnet; the wire being so arranged with respect to a contact stud that the said motion will cause the wire to touch and recede from the stud, so as to put into, and out of, circuit a local battery, the current from which operates the sounder, pen, or other device for indicating the words of a message.

7500. "Apparatus for utilising wind pressure to induce electricity, and for other purposes." W. K. HILLYARD and G. NEWNES. Dated May 9. 6d. On an inclined shaft able to turn in suitable bearings arranged so as to turn on a frame, is fixed a wind wheel or series of sails. This shaft is geared to a vertical shaft, which in turn by suitable gear drives a third shaft, from which by suitable means, such as a belt, a fourth shaft, which we will call the main shaft, may be driven. A clutch is provided to throw in and out of gear with each other the vertical shaft and the third shaft. From the main shaft, one or more electric generators or other machines may be driven. A tank or reservoir is provided at a suitable elevation, and the windmill is made to drive when desired a pump or pumps, whereby water is pumped up into the tank or reservoir. From the tank or reservoir, or tanks or reservoirs, is a pipe or pipes to a suitable motor or motors that can be operated by liquid pressure. Thus, such motor or motors can be used to drive the main shaft, and through it any machines that may be desired to work when the windmill is not in operation, it being understood that at such times the windmill may be put out of gear with the third shaft.

7668. "Electric meter." J. S. RAWORTH. Dated May 13. 6d. An iron spindle, capable of turning freely on pivots or bearings, has coiled around it, but not touching it, an insulated wire, and from its ends iron arms project. When the spindle is arranged vertically the following is one method of constructing the instrument:—The wire is led to the upper end of the spindle, parallel to and under the upper arm, is coiled around the spindle, passes under and parallel to the lower arm ascends vertically and returns above and parallel to the upper arm. The spindle has attached to it an adjustable torsion spring, and it may be provided with suspending fibres to relieve its pivot of a part or the whole of its weight; it is also provided with a pointer arranged to move along a graduated scale. When a current of electricity passes through the wire, the spindle is magnetised by the action of the coil, the arms forming polar extensions. As the current passes also along the wires running parallel to the arms, the latter are more or less deflected, both in the same angular direction, causing the spindle to turn partly round and its pointer to indicate on the scale the extent of the deflection.

CORRESPONDENCE.

Electrical Nomenclature, &c.

The great need of a thorough revision and systemization of electrical nomenclature and symbols was singularly well shown by Prof. Ayrton during the discussion which followed the reading of Mr. Jamieson's paper on this subject, before the Society of Telegraph Engineers. It was very comforting to hear this prominent scientist state that he prefers a certain symbolism, for the reason that "it is *often convenient*, at the end of a long mathematical expression, to be able to tell which is current and which resistance" (the italics are mine, not Prof. Ayrton's). There must be many people whose acquaintance with the real object of the mathematical treatment of simple electrical matters might lead them to dissent from this

opinion, but for my part I am in agreement with the professor. Although clearness on such a minor point is not absolutely necessary it may be well to express the hope that if only on Prof. Ayrton's account, no arrangement may be arrived at without giving the matter some attention. If it can be done without injury to the higher objects of mathematical treatment I think preference ought to be given to that system of notation which makes it possible for a student to identify his quantities. Of course, in practice such refinement as this is not necessary, although often convenient; in practice nature asserts herself. If Alumnus puts the sal ammoniac into the electric bell, and stuffs the wire into the porous pot, he probably finds there is "something wrong" with the arrangement, and tries another plan. But with the mathematical electrician the case is different. Nature does not come to *his* aid, and his "investigation" leads to the result that the electric bell and sal ammoniac develop an opposing E.M.F. which exactly balances that due to the wire and porous pot, consequently C = O, and the carbon and zinc do not ring.

Bill Stumps, his mark.

The New Telephone.

My attention having been drawn to the letter of "Telephonist" on page 456 of your issue for May 16th, I beg to state that "Telephonist" appears to be mistaken on several points respecting the instruments invented by Prof. Silvanus P. Thompson, and now owned by the New Telephone Company, Limited. The receiver differs in important points from that patented in 1882 in the name of Eldred, and is a modification of the Bell instrument which was described in the spring of 1876. The handle of the instrument as depicted in the ELECTRICAL REVIEW resembles, it is true, that of the D'Arsonval instrument, and that in turn resembles the handle of the older "pony-crown" instrument of Phelps; but there the resemblance ceases, as these instruments had permanent magnets for their handles. Moreover, the "plug" electro-magnet used in the circuit of Professor Thompson's instrument does not, as "Telephonist" imagines, involve the employment of extra battery power; on the contrary, it is employed for the express purpose of diminishing the number of cells of battery in the line-wire which would otherwise be needful to maintain a sufficient current to excite the electro-magnets of the receivers.

J. W. Barnard, *Secretary.*

New Telephone Co., Limited,
4, Great Winchester Street,
London, E.C., *May 20th*, 1885.

Winding Dynamos.

As Mr. Esson has offered some concluding remarks on this subject perhaps I may be permitted to do the same.

Mr. Esson has from the commencement made a mistake in supposing hypothetical figures are proofs, which they are *not*.

In my last letter I concisely restated both my own theory and that adduced by Mr. Esson, so that had he been actuated by more scientific motives than those of rhetorical display and self glorification, he would have been able to contrast the one theory with the other, and point out wherein lay the incorrectness of my theory, which is clearly incompatible with his own. He has attempted nothing of the sort, but has confined himself to rambling round the argument, making such statements as the following, "*about the accuracy of the formulæ (Mr. Esson's) and figures there is no question*," &c. Such remarks are not arguments, neither are they necessary to one.

But Mr. Esson makes a grave charge against me. "*Mr. Moon, with characteristic carelessness, distorts the equation by substituting r_1 for r on the right hand side, making it consequently meaningless.*" Passing over the insult offered, I would call attention to the fact that the formula is not altered by the exchange. Since if Mr. Esson uses r instead of r_1 he makes $\frac{C^2}{\left(C + \frac{E}{R_1}\right)^2} =$ 1, and his last equation, when correctly expressed, still reduces to his first $R_1 = \frac{E^2}{C^2 R}$ as before.

Mr. Esson also asks, do I still maintain that the figures given in his first paper are incorrect?

Yes, decidedly I do. In his first paper he gives the *E.M.F.* of the dynamo as 100 volts, but in his second article I notice that he ingeniously tries to scramble over the error by calling the *E.M.F. at terminals* 100 volts. The difference of potential at the terminals I presume he means.

Perhaps it is as well that Mr. Esson has offered his "concluding remarks" upon this subject, as throughout, I fear, he has evinced a greater love for wordy display than for fair argument, and therefore, to use his own expression, he has done well to withdraw, "happy in the complacency of his own convictions." "Mutato nomine, de te fabula narratur."

W. Moon.

May 16th, 1885.

Portable Electric Lamps.

Mr. Larochelle's address is 14, Avenue de Versailles, XVI^e^ Arrondissement, Paris.

J. A. Berly.

London, 18*th May*, 1885.

Pocket Batteries.

The cause of over heating in one cell of Mr. Aston's battery may either be that the zinc requires re-amalgamation or, as is frequently the case with these small cells, there exists a short circuit between zinc and carbon, very likely within the capsule. Should the zinc appear black and much corroded, re-amalgamation will remedy the fault; if on the other hand, the clean surface of the zinc indicates that the heating is not due to the too rapid decomposition of the metal, the capsule should be removed, and the connections be properly insulated.

Fredk. Walker.

36, Spondon Road, Tottenham,
May 17th, 1885.

Slow Speed Dynamos.

From the highly interesting articles concluded the 18th ultimo in the ELECTRICAL REVIEW under the head "Electric Lighting for Steamships," I understand that in your country the builders of dynamos have not yet succeeded in bringing down the number of revolutions to less than 400 to 500 per minute for a current of about 200 ampères, even where only 50 to 60 volts was to be the tension at the terminals of the machine. This circumstance induced me some days ago to have some experiments made with a shunt-wound dynamo built at my company's works; and as it might interest some of your readers I hereby beg to impart to you the following results:—

1. The field-magnets in shunt, but the whole shunt in one circuit: 460 revolutions, 110 volts, 190 ampères = 350 Edison's 16 C.P. A lamps.

2. The field-magnets in shunt, but in two parallel circuits: 360 revolutions, 60 volts, 200 ampères = 300 Woodhouse-Rawson's 20 C.P. lamps.

Should any further information be wished for, I am willingly at your service.

Ludv. Fredholm,
Managing Director,
Elektriska Aktiebolaget, Stockholm.

May 11th, 1885.

WOODHOUSE & RAWSON,

ELECTRIC LIGHT ENGINEERS, MANUFACTURERS, AND CONTRACTORS,

SUPPLIERS TO THE TRADE OF ALL ELECTRICAL APPLIANCES.

OFFICES—11, QUEEN VICTORIA STREET, LONDON, E.C.

Official Tests by Wimbledon Local Board:—

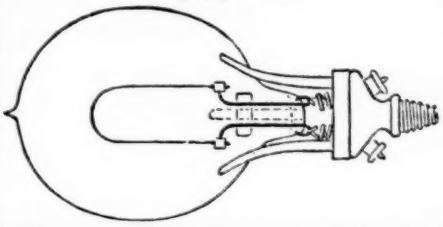
TIMES of *August 18th*.—"The lamps as finally adopted were the Woodhouse & Rawson Glow Lamps of 50 candle-power each, and these were variously arranged for the purpose of comparison as to the best method of suspension and light distribution. Some of them were placed singly and also in small clusters on poles 20 feet high, while others were suspended singly from cantilevers over the pathways and at a less height. Others, again, were suspended at a height of 20 feet above the centre of the roadway, and 100 feet apart. A current of 2 ampères was supplied to each Lamp, which takes 52 volts and 2 ampères, which equals 104 watts, and gives an efficiency of *2 watts per candle*. This, it will be seen, is a very high efficiency, that of the Swan Lamp being stated to be 3½ watts, and that of the Edison Lamp 4 watts per candle. It is noteworthy, too, that no breakage of the Lamps adopted occurred during the trials."

ALL LAMPS MARKED "WOODHOUSE & RAWSON."

Incandescent Lamps, Woodhouse & Rawson's Patent

NEW **5s.** FILAMENT.

Efficiency, 2¼ watts per C.P., 1 ampère for a 20 C.P. 45 volt Lamp. Reducing the cost of Electric Lighting 25 per cent.



WORKS—CADBY HALL WORKS, HAMMERSMITH.

DAILY NEWS of *April 11th* on the Wimbledon Comparative Tests.—"The night before last some experiments were made with the Woodhouse & Rawson Lamps, which were regarded as very successful, and indicated an amount of efficiency that was astonishing. This enterprising firm have recently made great strides in the improvement of Incandescent Lamps."

SUPPLY DEPARTMENT.

Enquiries are invited for

Engines, Dynamos, Accumulators, Arc and Incandescent Lamps, Lamp Holders, Safety Junctions, Switches, Terminals, Brackets, Shades, Cable, Wire, Instruments, Telephone Supplies, Carbons, Poles, Insulators, Battery Supplies, Glass Jars, Porous Pots, Chemicals, Electric Bells, Gas Lighters, Asbestos, Ebonite, Oil, Electric Jewellery, &c., &c., &c.

SPECIAL TERMS TO THE TRADE.

PRICE LISTS ON APPLICATION

REID BROTHERS,

12. WHARF ROAD, CITY ROAD, LONDON, N.

TELEGRAPH ENGINEERS AND CONTRACTORS

For the Supplying, Erecting, and Laying Down Under-Ground Wires, both for

TELEGRAPHS AND ELECTRIC LIGHTING

PNEUMATIC TUBES FITTED WITH ENGINES AND PUMPS COMPLETE.

MAKERS OF RADCLIFFE'S PATENT ELECTRICAL SIGNAL LOCKING APPARATUS.

PATENT TELEPHONIC WIRES

TO PREVENT INDUCTION BOTH FOR UNDER-GROUND AND OVER-HEAD LINES.

MANUFACTURERS OF SUBMARINE CABLES, WIRE, IRON POLES, INSTRUMENTS, BATTERIES, INSULATORS AND STORES OF EVERY DESCRIPTION.

Contracts entered into for the Supply, Construction, and Maintenance of Telegraph Lines.

CALLENDER'S

BITUMEN, TELEGRAPH AND WATERPROOF CO.,

LIMITED,

101, LEADENHALL STREET, LONDON. WORKS—ERITH, KENT.

MANUFACTURERS OF INSULATED WIRE FOR THE TRANSMISSION OF ELECTRICITY FOR ALL PURPOSES.

TELEGRAPHS, TELEPHONES, ELECTRIC LIGHTING, TRANSMISSION OF POWER, &c.,

AT A PRICE GREATLY BELOW THAT OF GUTTA-PERCHA OR INDIA-RUBBER.

ELECTRICAL POWER STORAGE COMPANY, LIMITED,

Offices:—4, GREAT WINCHESTER ST., E.C. Works:—MILLWALL, E.

Telephone Nos.—Office, 338; Works, 5,116. Registered Telegraphic Address—"STORAGE," LONDON.

SOLE MANUFACTURERS OF

THE "E.P.S." ACCUMULATORS

(Faure, Sellon, Swan, Volckmar and other Patents),

FOR ELECTRIC LIGHTING ON ARC OR INCANDESCENT SYSTEM, OR FOR MOTIVE POWER.

These are the only Accumulators which have been developed from the experience of three years' practical working.

Manufacturers of Electrical Tramcars and Launches, driven by Specially Designed Accumulators, and Reckenzaun's Patent Motors and Gearing; also Electrical Hoists, Main Distributing Switch Boards, Electro-Magnetic, Ammeter, and other Switches.

ELECTRIC LIGHTING FOR BALLS, DINNER PARTIES, &c.

Instruments Calibrated. Tests and Reports Made of Dynamos, Lamps, and Electrical Apparatus.

Contractors for Complete Installations of the Electric Light on the Most Approved Systems.

ELECTRICAL TESTING DEPARTMENT.

THE SCHOOL OF ELECTRICAL ENGINEERING.

Managers:— W. N. TIDDY, M.S.T.E.
W. LANT CARPENTER, B.A., B.Sc., F.C.S.
(*Member of the Physical Society of London; Author of "Energy in Nature," &c.*)

INVENTORS provided with **EVERY FACILITY** and the **USE** of all necessary **PLANT** and **MACHINERY** for **TESTING** or working out **ELECTRICAL INVENTIONS** and improvements of **EVERY DESCRIPTION.**

The utmost secrecy guaranteed, and advice given as to commercial value of new inventions.

Private Rooms and high professional assistance if required.

TESTS MADE AND REPORTS FURNISHED.

For further particulars apply to the SECRETARY, 12, PRINCES ST., HANOVER SQUARE, W.

ELECTRIC LIGHTING—GAULARD-GIBBS SYSTEM.

The National Company for the Distribution of Electricity by Secondary Generators, Limited,

18, Warwick Street, Regent Street, London, W.

Grand Prize and Gold Medal at the International Electrical Exhibition at Turin, 1884.

TO CORPORATIONS, ELECTRICAL CONTRACTORS AND OTHERS.—The above Company is prepared to treat for the use of its system, which is the only one by which house-to-house or other distributions over long distances is possible. Practical application of the system has been made over a circuit of 50 miles in length. Under this system there is great economy in main conductors, and each consumer may select any kind of lamp he pleases. The system can be seen at work in Bond Street, London, W.

EIDSFORTH AND MUDFORD, ARROW ELECTRICAL WORKS, JACKSON ROAD, LONDON, N. CLOSE TO HOLLOWAY STATION, (GREAT NORTHERN RAILWAY.)

Manufacturing and Consulting Electrical Engineers. Lists Free.

H. THORPE,

59, Theobald's Road, London, W.C.,

Wholesale Manufacturer of

ELECTRICAL INSTRUMENTS.

NEW PATENT SEMAPHORE INDICATOR NOW READY.

Parts of Apparatus made by Special Milling and Press-working Machinery, in quantities, to guage, or drawings.

QUOTATIONS FORWARDED.

ESTABLISHED 1851.

BIRKBECK BANK.—Southampton Buildings, Chancery Lane.

THREE per CENT. INTEREST allowed on DEPOSITS, repayable on demand.

TWO per CENT. INTEREST on CURRENT ACCOUNTS calculated on the minimum monthly balances, when not drawn below £50.

The Bank undertakes for its Customers, free of Charge, the Custody of Deeds, Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks, Shares, and Annuities. Letters of Credit and Circular Notes issued.

THE BIRKBECK ALMANACK, with full particulars, post free, on application.

FRANCIS RAVENSCROFT, Manager.

The Birkbeck Building Society's Annual Receipts exceed Five Millions.

HOW TO PURCHASE A HOUSE FOR TWO GUINEAS PER MONTH, with immediate Possession and No Rent to pay. Apply at the Office of the BIRKBECK BUILDING SOCIETY, 29, Southampton Buildings, Chancery Lane.

HOW TO PURCHASE A PLOT OF LAND FOR FIVE SHILLINGS PER MONTH, with immediate Possession, either for Building or Gardening purposes. Apply at the Office of the BIRKBECK FREEHOLD LAND SOCIETY, as above.

The BIRKBECK ALMANACK, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

KING, MENDHAM & Co.,

Western Electrical Works,

NARROW-WINE STREET AND FAIRFAX STREET,

BRISTOL.

WHOLESALE MANUFACTURERS OF

ELECTRIC HOUSE BELLS, PATENT NEEDLE POINT INDICATORS,

PATENT COMBINATION PULL AND PRESSELL,

IMPROVED PATTERN WIMSHURST ELECTRICAL MACHINE.

The "Science Teacher's" Set of Testing Instruments,

DYNAMOS, MEDICAL COILS, BATTERIES, SWITCHES, MOTORS.

COMPLETE STOCK of WIRES, CARBONS, TERMINALS, &c.

Price List Post Free, Four Stamps.

HEENAN & FROUDE,

MANCHESTER,

PATENTEES AND MANUFACTURERS OF THE

"TOWER" SPHERICAL ENGINE,

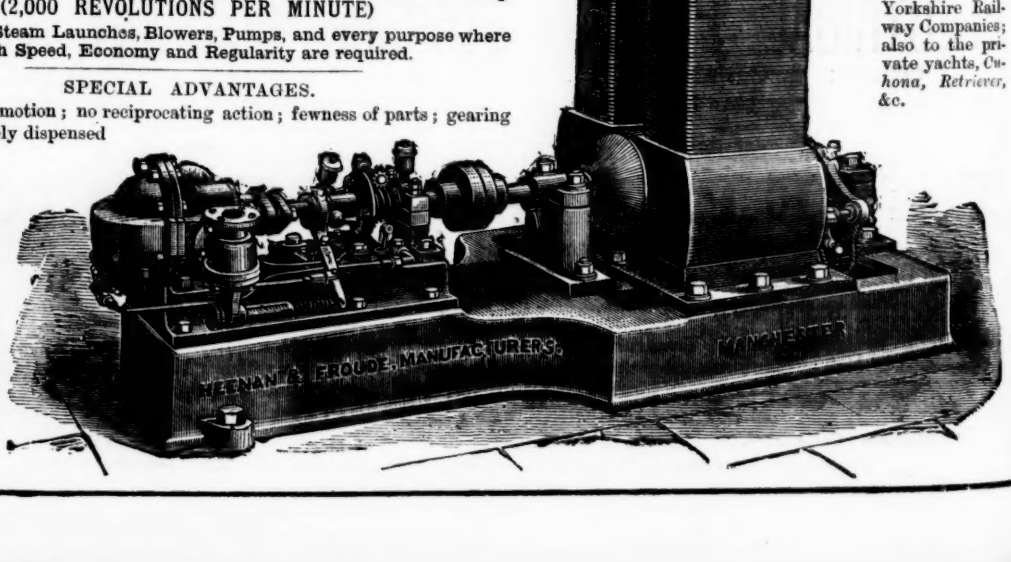
(2,000 REVOLUTIONS PER MINUTE)

For Dynamos, Steam Launches, Blowers, Pumps, and every purpose where High Speed, Economy and Regularity are required.

SPECIAL ADVANTAGES.

Steadiness of motion; no reciprocating action; fewness of parts; gearing or belting entirely dispensed with.

Less space occupied and less weight than any other engine (an engine realising 30 H.P. on the brake weighing only 2 cwt.) Working parts perfectly balanced and entirely closed and therefore inaccessible to grit, sand, or coal dust.



As supplied to Her Majesty's Dockyard, the British India Steam Navigation Co., the L. and N. W. Railway; and for *Train Lighting* to the Great Eastern and Lancashire and Yorkshire Railway Companies; also to the private yachts, *Cuhona, Retriever,* &c.